long term technical assistance

EU-AFD TECHNICAL ASSISTANCE PROGRAMME TO SUPPORT REFORMS IN THE WATER AND WASTEWATER SECTORS IN LEBANON

Funded by the European Union

Implemented by AFD

A9 : INITIAL DIAGNOSIS OF THE WATER ESTABLISHMENTS

DATA COLLECTION AND DIAGNOSIS REPORT

Beqaa Water Establishment

REVISED EDITION

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CONTENTS

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ACRONYMS

AFD	Agence Française de Développement
ALI	Apparent Loss Index
AWWA	American Water Works Association
BMLWE	Beirut and Mount Lebanon Water Establishment
BWE	Beqaa Water Establishment
Capex	Capital Expenditures
CEO	Chief Executive Officer
CMS	Client Management System
DG	Director General
DMA	District metering area
DMAs	District metering areas
EDL	Electricité Du Liban
EDZ	Electricité De Zahleh
ERP	Enterprise Resource Planning
EU	European Union
GAAP	Generally Accepted Accounting Principles
GIS	Geographic Information System
HR	Human Resources
ILI	Infrastructure Leakage Index
IT	Information Technology
IWA	International Water Association
KPI	Key Performance Indicator
KPIs	Key Performance Indicators
KVA	Kilo Volt Ampere
LBP	Lebanese Pound
LRA	Litani River Authority
LWP	Lebanese Water Project
M LBP	Million Lebanese Pound
MCM	Million Cubic Meters
MoEW	Ministry of Energy and Water
NGOs	Non-Governmental Organisations
NLWE	North Lebanon Water Establishment
NRW	Non-Revenue Water
NWSS	National Water Sector Strategy 2020
O&M	Operation and Maintenance
Opex	Operation Expenditures
P&L	Profit and Loss
PI	Performance Indicator

PIs	Performance Indicators
PS	Pumping Station
RWE	Regional Water Establishment
SCADA	Supervisory Control And Data Acquisition
SLWE	South Lebanon Water Establishment
TA	Technical Assistance
UARL	Unavoidable Annual Real Loss
UNICEF	United Nations International Children Emergency Fund
USAID	United States Agency for International Development
VAT	value Added Tax
WE	Water Establishment
WEs	Water Establishments
WTP	Water Treatment Plant
WW	Waste Water
WWTP	Waste Water Treatment Plant
WWTPs	Waste Water Treatment Plants

1 INTRODUCTION

Within the framework of the project "*Technical Assistance Programme to support Reforms in the Water and Wastewater sector*", funded by the European Union and implemented by AFD, Activity A9 stipulates to "*Carry out an initial diagnosis at the WEs*".

The purpose is to carry out a diagnosis performance study for the four WEs, aiming to assess their actual situation through the identification of strengths and weaknesses and critical issues along with possible actions/takeaways for the water establishment to implement service management to international standards, in line with the requirements of the NWSS.

The end goal is to eventually define strategic well-tailored orientations for each WEs, and to identify and implement pertinent KPIs for performance monitoring.

The activity was carried out in two-steps: Data collection, then preliminary diagnosis, covering:

- Technical matters:

  The assessment of the actual situation of human resources (quantitatively and qualitatively, job description, adequacy of the positions with the current profiles, description of the reference frame of the professions and in particular of the new professions that the RWE will need in the coming years, organization structure, etc.).

  The NRW: analysis of the major ratios of production, loss and sales actually collected and cleansed

  Energy related issues: Analysis of energy consumption, source of power, power optimisation and else.

  O&M issues : O&M procedures, O&M system components, existing water systems and planned new infrastructures, Information system, Quality of service in terms of complaints system and service coverage.

  And in general all administrative and technical aspects of the WEs activity.

- Financial matters:

  Revenues analysis covering tariffs, budgets, cash flows, profit and loss, billing system and collection rates, accounting system, water sales, subscription rates.

  Expenditures analysis covering Opex analysis and cost recovery.

  Expenditures related to Capex are not addressed in these preliminary diagnosis reports, due to the lack of relevant data in all four WEs. These will be tackled later on in the final diagnosis reports to be prepared subsequently to this report.

Four separate *Preliminary Diagnosis* reports are produced, one for each WE, structured as follows :

1. Introduction – Legal framework
2. Section A: Executive summary - Findings and recommendations
3. Section B: Technical Performance Diagnosis
4. Section C: Financial Performance Diagnosis
5. Section D: Collected Data

In addition, a brief historical background and legal framework of the four WEs is given herein under. More details and key figures and services provided by each WE are given at the beginning the relevant Executive Summary, in order to provide the reader with a full but concise picture on the WE before focusing on diagnosis's results and recommendations.

The present report covers the preliminary diagnosis of BWE.

2 HISTORICAL BACKGROUND – LEGAL FRAMEWORK

Until 2000, 21 water authorities were in charge of the supply of potable water throughout the Lebanese territory: eight in the North, six in Beirut and Mount Lebanon, four in the South, and 3 in the Beqaa. Of these, only the Beirut Water Authority (today BMLWE) was an independent authority with its own budget and board, under the tutelage of the Ministry of Electric and Hydraulic Resources (today Ministry of Energy and Water - MoEW). The others were under the direct authority of the ministry.

The result of this fragmentation in service provision was a lack of strategic planning and implementation across the regional service areas, which needed to be managed in a more effective, reliable and sustainable manner

Law № 221/2000 of May 29, 2000, rectified by law № 241/2000 of 7 August 2000 and amended by law № 377 of 14 Dec 2001, re-organizes the water sector in Lebanon, introduces the principles of Integrated Water Resources Management (IWRM), and improves efficiency in service provision.

Under this new regulation, the former 21 water authorities were consolidated into four Water Establishments as follows :

- NLWE, based in Tripoli, merges the former water authorities of Batroun, Bcharreh, Minieh-Dannieh, Halba, Koura, Qbaiyyat, Tripoli and Zgharta.
- BMLWE, based in Beirut, merges the former water authorities of Beirut, Metn, kesrouane, Jbeil, Chouf, and Ain el Delbeh.
- SLWE, based in Saida, merges the former water authorities of Saida, Nabeh el Taseh, Sour and Jabal Amel.
- BWE, based in Zahleh, merges the former water authorities of Baalbeck-Hermel, Zahleh, and Chamsine.

On July 3, 2002, Bylaw 8122 set out the merger of all the former water authorities (as well as all communities, local committees and else, operating and managing drinking water, sanitation, and/or irrigation facilities) under the jurisdiction of the above four WEs.

On the administrative level, Article 5 of Law 221/2000 and its amendments states that the four WEs are independent public bodies, governed by a Board of Directors of six members and a CEO, all appointed by decree. The Board is entrusted with establishing all the internal regulations of the WE. The WEs works under special regulations, under the tutelage of the Oversight Department of MoEW.

The adoption of the Law 221 in 2000 led to the promulgation of a number of by-laws in 2005 as follows:

- Decree 14598 of 14/6/2005 – Rules of procedure
- Decree 14599 of 14/6/2005 – Operating rules amended by Decree 1756 of 16/4/2009
- Decree 14636 of 16/6/2005 – Financial regulations
- Decree 14875 of 1/7/2005 – Staff rules and regulations
- Decree 14916 of 5/7/2005 – Administrative organization

The operating rules are the same for all four WEs, except for SLWE where Articles 56 through 86, which govern matters related to irrigation, are not relevant as irrigation in South Lebanon falls under the Litani River Authority (LRA) and not SLWE as is the case for the three others.

The tasks of the WEs can be summarized as follows:

- Study, implement, invest, maintain and renovate water projects to distribute drinking water.
- Collect, and treat wastewater and dispose of effluents and sludge
- Propose tariffs for drinking water and wastewater disposal services.
- Monitor the quality of distributed drinking water and treated effluents.

In 2005, a number of related by-laws were promulgated:

- Decree 14602 of 14/6/2005 – Rules of procedure
- Decree 14603 of 14/6/2005 – Operating rules amended by Decree 1757 of 16/4/2009
- Decree 14639 of 16/6/2005 – Financial regulations
- Decree 14874 of 1/7/2005 – Staff rules and regulations
- Decree 14913 of 5/7/2005 – Administrative organization

3 DATA COLLECTED

The range period of the data collected was mainly the past five years from 2017-2020. However, when available, data ranges from 2015 were provided by the WE.

The data collected covers all what is available to date on:

- Human resources and organization structure
- Technical data in relation with system information (GIS, ERP, etc.), water systems and infrastructures, Water resources and production, Energy use and consumption, O&M approach and system (SCADA system), Water quality.
- Customer service (Subscribers, quality of service, service coverage, etc.).
- Economic and financial data covers the revenues, expenses, tariff and subscriptions, collection, billing, budgets, trial Balance, Administrative and Commercial accounts, cash flow, ERP system, etc.
- Audit and monitoring system.

SECTION A
EXECUTIVE SUMMARY - RECOMMENDATIONS

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A.1 INTRODUCTION

The structural degradation of the past two decades has transformed the WEs into non-efficient utility vehicles on different functional levels. In addition, the present environment prevailing since 2019 has added to the complexity of the development process. The present crisis, specially the resulting high increase in transportation cost, has crippled all activities that require human intervention, human presence, or human governance. It has also revealed the vulnerability of production facilities to shortages in power supply. The non-efficient production and distribution means, poor governance tools, and data scarcity have also reflected heavily on the situation.

It has now become imperative to adopt alternative perspectives to weather the consequences of the economic and financial meltdown in the country.

Any remedial and development endeavour surely requires, as a prerequisite, the strengthening of the Establishment in the following – but not only – fields :

- Strategic vision

The WE should elaborate and implement a clear development strategy setting out the objectives to be achieved and the way to achieve them within a scheduled time frame.

The utility provider has to be able to sustain water supply; and at the same time, it has to undergo a rigorous development program that abides to this strategy.

BWE defines its vision and mission statement as follows :

"Transform the Establishment into a modern utility capable of providing the full range of water supply, wastewater and irrigation services to the region, in line with international best practices, while coordinating with all concerned parties to protect the environment surrounding surface and ground water resources."

- *Apply best practices of integrated water resource management to improve the protection of water resources.*
- *Extend water supply and wastewater services to all residents in the service area of the Establishment, where it is economically feasible, and achieve equity in the supply of water to all customers.*
- *Plan and manage wastewater treatment to protect all natural receiving streams in the Bekaa Valley.*
- *Raise the water awareness of the general public and public officials on the complexity and cost of water supply, wastewater and irrigation services to create more transparency and support for tariffs and investment programs.*

However, there is no specific line of action set to reach the targets.

A five-year business plan was developed in 2005, to integrate the merged authorities functions, address the employee count and qualifications, and quantify investments needed for new capital projects, hiring of permanent employees, streamlining operations, adopt household water metering on new projects, rationalize operation and maintenance, and automate financial and administrative processes. The target was high and July 2006 war reshuffled it all.

Another business plan was adopted in 2013 and updated in 2015, but fell short of achieving expected results due to the vacancy in BWE director position, freeze on hiring, flaws in the organization structure, delays in ratifying the water code, lack of coordinated investments, and external events such as the Syrian crisis and the subsequent large influx of refugees.

The latest business plan (2016-2020) must be reviewed, taking into consideration obstacles that hindered its adequate implementation, as well as the new social and economic developments that unfolded since October 2019.

Therefore, the whole BWE strategy must be reviewed setting out realistic targets and the means to achieve them within a set timeframe.

- Establishment's structure

The first step is to revise the structure of the WE and set up a new organizational structure in order that it supports both functional and development processes.

- Human resources

Revisions to BWE organization chart were proposed to match its mandate and responsibilities, reorganizing existing departments, and adding wastewater and irrigation departments. These revisions were not approved by the ministry, and were not implemented.

Furthermore, and due to the current crisis and the dramatic fall in wages, the employees of the establishments (essentially the most qualified and most experienced) are leaving. Additionally, WEs are not allowed to hire, and if so, the official wage scale has become too low to attract applicants. Therefore, the human resources of WEs are slowly depleting.

The establishment has to be able to retain its human resource by being allowed to hire and to raise wages to acceptable levels.

- Data acquisition and management

Systems for data management have been installed at BWE: ERP/Navision, CRM - GIS - Scada for accounting, administration, customer care, and operations management. These systems are still not fully functional or reliable, as they are incomplete, and lacking experienced operators.

Considering the present great difficulties to retain the human resources, the experience and the knowledge base of the establishment have to be preserved at least. The system has to overcome the challenges of the high turnover rate especially the time required by newcomers to merge into the workplace. The turbulent environment the establishment has been passing through requires rigorous and continuous change management activities that consumes lots of time and energy of the management team.

Therefore, data has to be properly collected and preserved. No development program can work effectively if it is not based on real and accurate data. This includes credible data collection means, archiving, and processing. The digital transformation of the WE is an essential and necessary milestone in the route towards sustainability.

- Governance

Another challenge to be realized is the proper governance of the all functional, commercial, and quality processes. The establishment is sustainable if it is commercially viable. Commercial viability implies a turnover with a positive profit to loss ratio and positive cash flow. Add to this, a growing establishment implies an increasing annual asset valuation. Quality governance is an integral part of the establishment's ethical and professional mission. Functional governance is a necessity for an adequately performing establishment. Another reason for a necessary digital transformation.

- IT and Communication infrastructure

Proper and credible data collection activities, in addition to the digital transformation, require a concrete and reliable IT and Communication infrastructure. This includes integrated software that can work together and with the central ERP software. The communication means have to be reliable and commercially feasible.

- Billing and collection

At the bottom of commercial viability and turnover growth are billing and collection. Customer segmentation, tariffs, payment portals, among others, can be included in a comprehensive billing solution. The collection process reflects the performance of a number of processes within the establishment. Collection can always be increased by keeping a comprehensive and up-to-date customer database.

- Adequate Master Plan in order to secure consistent water supply

BWE 2015 Master Plan is mostly based on the use of surface water for drinking and irrigation; and identifies self sufficient water systems including production, storage, and distribution to gradually meet expected demand in 2035.

Efforts have been made to implement new projects in line with this Master Plan. However, these have been hampered by sources of funding favouring specific areas, unforeseen residential extensions, the continued presence of displaced Syrians, and above all social blockage due to self-proclaimed traditional water rights.

Therefore, it is necessary to review this Master plan according to the real situation on the ground.

- Production cost

  For a utility provider that depends solely on its collection for revenues, a positive cash flow can only be guaranteed by a profitable operation. Increasing profit can be realized by controlling production cost, which mainly consists of energy cost.

  Energy cost can be optimized by choosing adequate energy sources and by decreasing the energy demand of production facilities. Production facilities require less energy if they produce less water as well. Automation is a necessary requirement for a well-governed process.

  BWE has already implemented 30 solar power plants installed on production and chlorination facilities (with a capacity in excess of 3.5 MW) and WWTP's. Additionally, 23 systems are planned or under execution.

  BWE must acquire the means to sustain this effort.

- Automation

  Less water production implies optimized distribution. This means that supply adequately meets demand. The quantity of water produced has to closely match the required volume to satisfy demand. Non-revenue water (NRW) has to be kept minimal, whether technical or due to unauthorized connections. Pressure in the network has to be compatible with the customer demand curve to control the technical losses.

  Human interference to control distribution valves proved detrimental and incompatible with this endeavour and has to be reconsidered.

  Therefore, Automation is a necessary requirement for optimal distribution.

- Water quality

  Distributed water quality is an essential parameter and has to be compatible with national water standards. The community’s ability to purchase drinkable water or to access health facilities in case of illness has been greatly compromised. Enhancing and guarantying water quality can also increase the subscribers’ base and their willingness to pay a higher tariff.

  There is currently one central Laboratory in Zahleh, that is unable to systematically cover quality tests across BWE jurisdiction, is short on consumables and test materials, and can no longer gather samples from remote areas due to transportation costs.

  Water quality and chlorination teams were created in 2017-2018 manned by contracted employees for that purpose, but were unsuccessful in completing the required tasks.

  Regional Labs as well as mobile labs have been on BWE needed list for a while, for adequate water quality sampling, and monitoring, but still lacks funding sources.

- Wastewater

Sewage is a pollution hazard that poses great risk on water quality at its source.

Management of the sewage sector is by law the responsibility of the WEs. Ideally, it should be designed, implemented, and operated to complement water systems in the supply of water for irrigation and possibly industry. This is not the case presently

The legal and structural framework allows the intervention of other stakeholders (such as the Ministry of environment (MoE), the MoEW, the CDR, and the municipalities) in the sector. This, of course, hinders the direct operation of the sector by the WEs.

The sewage sector ought to be monitored and managed by the WEs, while operation could be done by others (i.e. municipalities and/or private sector). The other stakeholders should all participate, within their duties, to make the management of the sector possible. For example, the quality of the sewerage, the standards of the effluent, storm water, among others should be attended to by the concerned stakeholders as they fall beyond the mandate of the establishments.

- Irrigation

Scarcity of the water resources and the high interaction with the supply of potable water requires rationalization of irrigation schemes.

Irrigation is by law part of the core missions of BWE. Ideally, it should be designed, implemented, and operated to optimize the use of water for irrigation by adopting new irrigation methods and by using the treated waste water.

A great need to modernize irrigation laws in a view to facilitate and organize the use of water for irrigation through the setting up of irrigation department in the organizational structure of the WE for monitoring and management and the creation of farmers' associations for operation and maintenance.

- Water Establishments sustainability

Water establishments in Lebanon are still non-sustainable.

All efforts should be invested to transform the establishments into sustainable enterprises within a midrange period. From what has been studied until to date, BWE can surely be transformed into a sustainable enterprise if the right decisions are made.

One way would be to realize the core activities of the establishments as to outsource some or all of the non-core activities to private or other public entities that may be able to guarantee the operation of these non-core activities.

However, for the water utility providers to achieve their sustainable full capacity, interventions are required on the functional, structural, and legal levels in order to develop production, distribution, and quality activities in a methodical manner.

A.2 BWE GENERAL OVERVIEW

BWE serves a geographic area of approximately 4,250 Km² divided, for service and management purposes, into four potable water distribution sections as shown in Figure A 2-1. Limited irrigation services are provided in the areas of Yammouneh and Deir Al Ahmar, as irrigation services in the Beqaa are mainly under the Litani River Authority (LRA).

The supplied population is around 750,000 (2020) with approximately 220,000 housing units, out of which approximately 40% are subscribed to the water supply service.

The water supply sources of NLWE consist of a combination of 69 wells, 79 pumping stations, 3 treatment plants and 153 springs. The length of the network is 6,000 km with 67,500 connections.

The water supply sources of BWE consist of a combination of 102 wells and pumping stations, 2 treatment plants, 4 springs and 1 dam. The length of the network is 4,000 km with 51,400 service connections.

BWE has the authority and responsibility to provide sewerage collection and treatment services. This was traditionally under the responsibility of the municipalities until the enforcement of law 221/2000. To date, BWE is operating 3 WWTP (+1 WWTP not operational) and 10 related lift-up station but did not take over the existing sewers for a lack of both financial and human resources. Therefore, municipalities are still managing the collection networks and a number of WWTPs.

Table A 2-1 below provides a general overview of BWE's key figures.

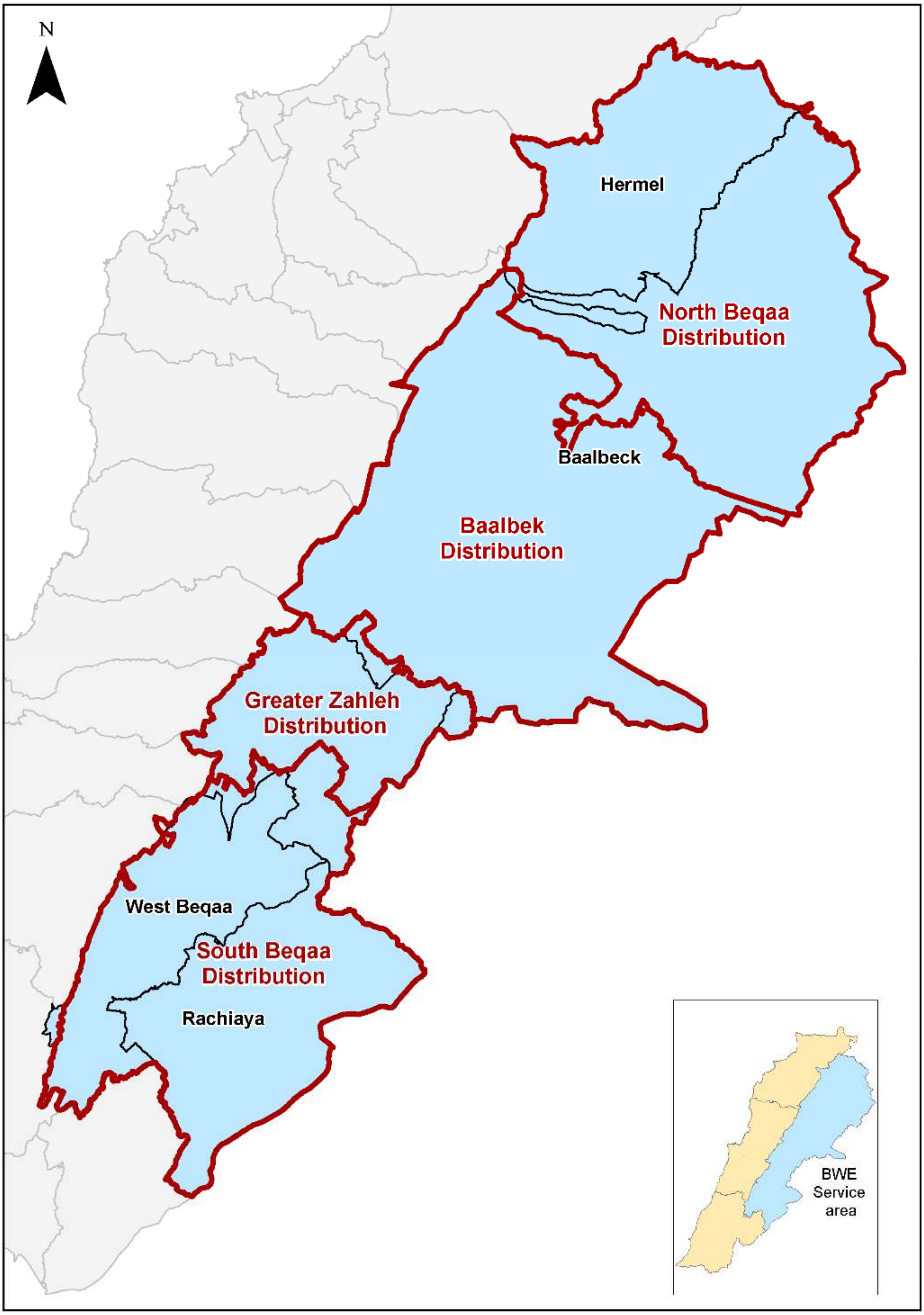

Figure A 2-1 BWE service area

Table A 2-1 BWE General Overview (2020)

Population	
Estimated population served	750 000
Nbr of municipalities	250
Nbr of Housing Units (BWE + others)	220 000
Nbr of connections (BWE + others)	55 000
Housing units per connection	4
Subscribers	
Metered subscriber	32 401
Gauged subscribers	56 582
Total subscribers	**88 983**
Rate of metered subscribers (%)	36%
However, meters are not read and billed as gauges	
Water production	
Volume produced (Million m³/Y)	53
Collection rate (%)	45%
Est. NRW rate (%)	31%
Water Resources & Infrastructures	
Nbr of Water TP	2
Nbr of Wells and P.S.	102
Nbr of Springs	4
Nbr of Dams	1
Est. length of the water networks (km)	4 000
Wastewater	
Nbr of WWTP under BWE jurisdiction	
Operated by BWE	3
Operated by Municipalities	3
Operated by CDR	1
Under Construction	2
Not operational (BWE's Ownership)	1
	10
Length of existing sewer	Not Known
Staffing	
Nbr of actual employees (Permanent + On demand)	374

A.3 PERFORMANCE DIAGNOSIS SUMMARY

A.3.1 HUMAN RESOURCES

Figure A 3-1below shows BWE's organization chart as specified by Bylaw 14916 of July 2005 (*The Organisation of the Bekaa Water Establishment and the details of its employees, grades, salary scale, and hiring conditions*)

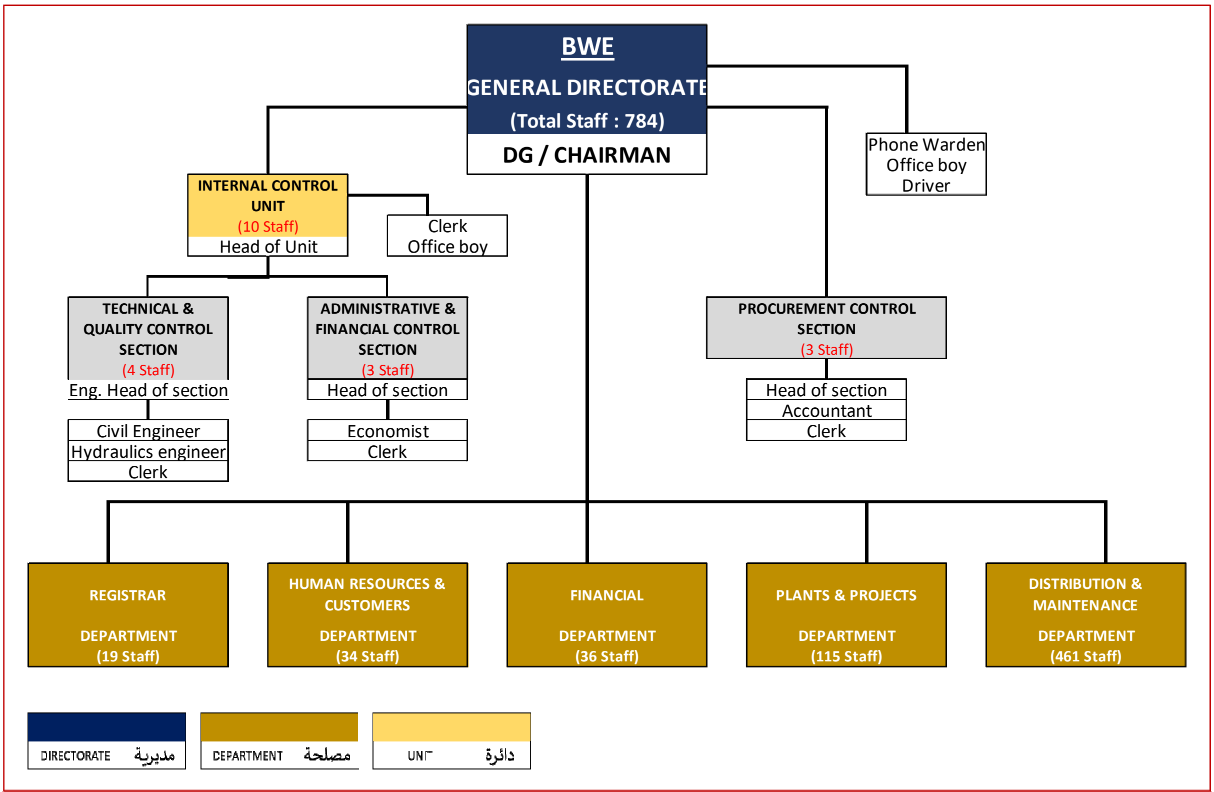

Figure A 3-1 BWE General Organigram as per By-Law № 14914/5 of July 2005

Detailed Organisation charts by department are provided under *Section D*

Total employees number should be 784, of which only 164 positions are presently (2021) filled, which amounts to 79% vacancy.

Article 21 of law 46/2017 provides for a ban of employment in all public institutions and establishments. To circumvent this ban, BWE (like all other WEs) hires on-demand staff to fill not only operational but also business development positions, ended up with 374 (2021) on-demand personnel representing 56% of the total 374 (164 + 210) present staff.

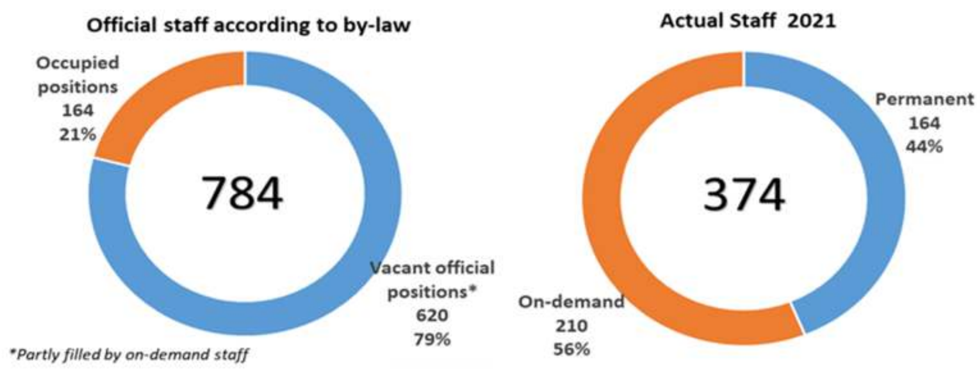

Figure A 3-2 Staff allocation (2021)

The assessment of staff productivity as measured by the number of staff members per 1000 connections was not possible due to the large uncertainty of the number of connections; therefore, the number of subscribers and the number of potential customers were used as alternative methods. The analysis shows that BWE is not understaffed, thanks to temporary on-demand staffing. However, there is a sharp lack of qualified personnel, which is the key factor behind the WE lack of operational capacity and the low levels of service. The gap between the number of staff specified in the WEs' organizational decrees and the number of positions occupied is a key indicator.

Due to the deteriorating economic situation and the devaluation of the national currency, BWE is facing high turnover rate of experienced employees and is risking the loss of their knowledgebase.

A.3.2 WATER PRODUCTION

Presently, the water production is not adequately monitored due to the lack of flow measurement equipment in some of the water sources and the absence of telemetry solution for a simple monitoring system or SCADA system for a fully automated monitoring water management system at the wells, springs and pumping stations. Production figures given by BWE are known by region from 2017 to 2020 yet, it is based on operators' best estimate.

In 2021, the electricity outage and the rise in fuel prices triggered by exchange rate fluctuations would adversely impact the water volumes pumped; a decrease in water production and a decline in the number of hours of supply are to be expected.

A.3.3 WATER DISTRIBUTION - NRW

In order to examine the nonrevenue water at BWE, the analysis adopted a well-known procedure of top-down assessment and bottom-up assessment. However, the accuracy of production quantities, actual water consumption and the absence of DMAs are recognized as the main areas of concern.

Almost all production quantities are based on estimates of production and approximate working hours, while the actual water consumed by the customers cannot be known due to the absence of metering practices. On the flip side, the bottom-up estimate of real losses is ideally conducted on the level of a district-metered area, but the distribution networks are not organized into DMAs and there is no flow measurement at the level of the local reservoirs except for some very limited distribution zones.

The lack of data coupled with absence of DMAs compromised the accuracy of the results. The nonrevenue water has shown little progress between 2019 and 2020 and it is estimated by 47%. The vicious circle of NRW is one of the key reasons for poor utility performance and results in both physical and commercial losses. The analysis of the available data shows that the high NRW levels are mainly caused by commercial losses resulting from inefficiencies in billing, illegal connections and theft. The real (physical) losses are estimated to be 5%. While it is hard to draw any stroke conclusions from the current data, it is worth noting as an area for further research.

A.3.4 WATER QUALITY

As for the quality of water, the data show that BWE developed its own water quality management program "عين" in 2019 to consolidate the water quality results in an accurate, reliable and comparable database, to reduce human error and to ensure the compliance with the national standards and international goals of water safety. The system enables the laboratories and departments to improve their processes and services by accessing and analyzing water quality information and make data-driven decisions. The system is coupled with GIS-based dashboard to visualize the data in a timely manner and to monitor the water supply chain by locating pollution incidents without carrying intensive sanitary surveys.

A.3.5 WASTEWATER

Legally, the wastewater sector in full (collection networks and treatment facilities) is under the responsibility of the WEs. Most of the wastewater system (collection networks and treatment facilities) have been implemented by CDR, who is still operating Zahleh WWTP while the others were handed over to BWE. Municipalities are operating 3 plants in Fourzol, Ablah, and Aitanit. In addition, a number of small WWTP were constructed by USAID, but few of them are still in service, operated by local municipalities, while most are now abandoned.

BWE is reluctant to take over this sector, mainly for (i) the lack of funds to operate it and (ii) the lack of adequate expertise among the present WE's staff. Before providing necessary financial and human resources, BWE cannot take over and operate any new wastewater facility. This would be achieved when (i) a new organization chart is implemented and authorization to hire is given to the WEs and (ii) when a new tariff allowing the WE to cover the Opex is enforced.

The current status of the major treatment facilities is shown on Table A 3-1.

Table A 3-1 Existing WWTP in BWE jurisdiction.

Treatment plant name	Service area and covered villages	Operated by	Capacity M³/day
Iaat	BaalbekDourisAnsar Ain Bourday	BWE	12 000
Joub Jannine	Lala, Jeb Jannine, Kamed El Lawz, Sultan Yaakoub, KherbetKanafar, Kefrayya, Ain Zebde, Mansoura, Aana, Tal Znub, DeirTahnish, Ghazze, Hawsh El Harimi, Khiara	BWE	10 000
Saghbine	Saghbine, Bab Mare, Ain Zebde	BWE	560
Zahleh	Hazerta, Ksara, Ouadi el Aarayech, QaaEr Rim, Saadnayel, Touayteh, Zahlehh	CDR	40 000
Yammouneh	Yammouneh village	Not operational	- -
Fourzol	Fourzol	Municipality	1 000
Ablah	Ablah	Municipality	2 000
Aitanit	Aitanit, Baaloul, Qaraoun, Machghara	Union of municipalities	5 000

A.4 FINANCIAL DIAGNOSIS SUMMARY

A.4.1 KEY FIGURES

Table A 4-1 below summarises the financial key figures of BWE. Financial data for 2020 was not available.

Table A 4-1 BWE Financial Key figures

``		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		(year ends December 31)									
Subscribers, production, NRW											
Total number of customers		72,240	75,239	77,334	79,030	81,726	83,837	85,111	86,761	87,979	88,983
of whom water meters (but not read)											
Volume produced entering into the system	m³/year	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	56,000,000	53,981,983	53,670,099	53,183,820
Volume billed/subscribed	m³ /year	29,895,325	31,136,325	32,003,200	32,705,095	33,820,900	34,694,710	35,221,770	35,904,685	36,408,750	36,824,120
Estimated NRW rate		56%	54%	53%	52%	50%	49%	37%	33%	32%	31%
Revenues; Collection rate; Operating cost											
Accrued revenues	LBP	13,991,980,000	14,388,588,000	19,065,449,000	19,822,238,000	20,129,313,000	22,869,195,332	23,976,962,624	24,290,499,933	24,964,880,799	25,431,943,516
Actual revenues	LBP	8,513,209,025	9,112,388,851	10,821,174,302	10,778,015,743	10,567,191,985	9,941,114,740	11,202,188,509	12,435,463,000	11,559,948,750	11,434,634,913
Annual collection rate		61%	63%	57%	54%	52%	43%	47%	51%	46%	45%
Operating cost	LBP	13,479,927,665	15,995,695,962	16,179,609,304	17,784,759,813	16,738,348,097	17,277,000,471	21,152,223,323	20,597,113,526	22,579,090,177	21,202,970,717
Operating result, EBITDA											
EBITDA in case 100% collection rate	LBP	512,052,335 (4%)	-1,607,107,962 (-11%)	2,885,839,696 (15%)	2,037,478,187 (10%)	3,390,964,903 (17%)	5,592,194,861 (24%)	2,824,739,301 (12%)	3,693,386,407 (15%)	2,385,790,622 (10%)	4,228,972,799 (17%)
Actual EBITDA considering actual collection rate	LBP	-4,966,718,640 (-58%)	-6,883,307,111 (-76%)	-5,358,435,002 (-50%)	-7,006,744,070 (-65%)	-6,171,156,112 (-58%)	-7,335,885,731 (-74%)	-9,950,034,814 (-89%)	-8,161,650,526 (-66%)	-11,019,141,427 (-95%)	-9,768,335,804 (-85%)
Cash situation											
Cash situation	LBP	12,202,263,154	17,285,125,912						12,514,369,412	7,463,218,238	2853610278
Account Receivables	LBP	87,064,840,000	92,341,039,000	100,585,314,000	110,147,435,000	123,075,516,000	135,850,290,000	147,705,327,000	161,110,259,000	175,107,567,000	189,104,875,603
Estimated Amortization											
Rates for 1 m³											
Nominal selling price (based on accrued revenues)	LBP/m³	468	462	596	606	595	659	681	677	686	691
Actual selling price (based on actual collection)	LBP/m³	285	293	338	330	312	287	318	346	318	311
Nominal operating cost (based on volume produced)	LBP/m³	198	235	238	262	246	254	378	382	421	399
Actual operating cost (based on volume billed)	LBP/m³	451	514	506	544	495	498	601	574	620	576

A.4.2 PROFITABILITY, SUSTAINABILITY

On the financial side, the analysis concentrated on profitability, liquidity and solvency of the WE. A particular attention is paid to the EBITDA, which reflects the profitability of the business together with the capacity to produce sufficient cash-flow.

Generally speaking, BWE is not in a good financial situation as revenues do not meet O&M costs, leaving the WE without the capacity to replace worn-out assets and the situation has deteriorated after 2019 due to the financial crisis.

Operating result in 2019 is a loss amounting 10% of the accrued revenues with a negative EBITDA. In other words, even with a 100% collection rate, the gross margin is negative. As a consequence, the WE is suffering of treasury problems and due to a low collection rate (35% In average), the accounts receivables are accumulating. In 2019, Accounts receivables by the end of the year were 7 times the annual turnover and the trend is not favourable. On the long run, such accumulation of bad debts will require a provision for unpaid bill.

Major cause for such bad situation is the low and unchanged tariff while O&M costs are increasing. BWE is in a situation where O&M costs are higher than the official tariff I and the situation worsens considering the low collection rate. In other words, even with a 100% collection rate, the WE is experiencing losses.

A.4.3 OPEX COST RECOVERY

The analysis reveals the impact of the cost of energy on operational expenditures.

In 2019, energy costs was 34% of the total Opex, against 36% for labour, and 20% for maintenance cost. With a total of 70%, energy and staff costs have the greatest impact on Opex. However, in 2022, the cost of energy became preponderant with nearly 56% of the Opex (Figure A 4-1 below).

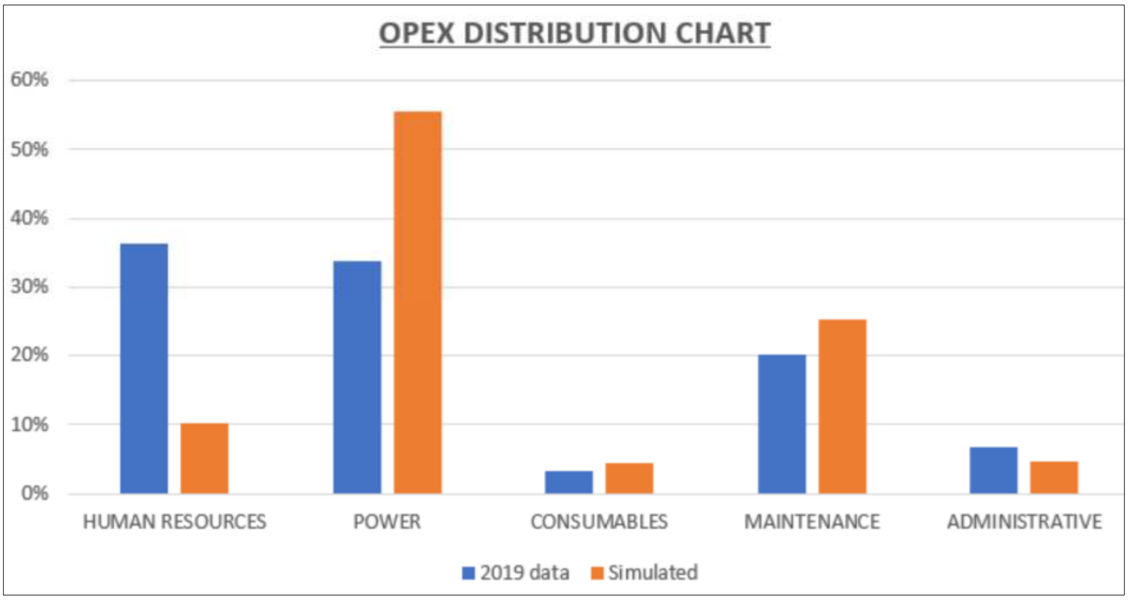

Figure A 4-1 Opex distribution : 2019 v/s 2022 (simulated)

Presently, the situation has worsen with the rising inflationary pressures, the devaluation of the Lebanese Pound and the rise in energy prices. BWE now barely covers 5% of the operational costs compared to 44% prior to economic meltdown (with the tariff in force in 2021).

The required tariff to balance the estimated 2022 Opex is around 6 Million LBP, which is simply not applicable from the socio-economic point of view.

Table A 4-2 Compared Opex Cost Recovery 2019 – 2022

2019

Operational Revenues : 24 965 M LBP		Cash Flow : 10 288 M LBP		Total OPEX : 23 150 M LBP	
Financial Indicators (Base value)		**Collection rate assessment**		**OPEX Breakdown**	
Exchange Rate :	1 500 LBP/USD	Invoiced :	24 965 M LBP	HR	8 402 M LBP
Fuel :	850 LBP/l	Collected :	10 288 M LBP	Power	7 795 M LBP
Gazoline :	25 000 LBP/20 l	Collection Rate	41%	EDL	5 865 M LBP
Transportation :	8 000 LBP/day	Cost recovery	44%	EDZ	1 180 M LBP
Kwh from EDL :	84%			Generators	750 M LBP
Kwh from EDZ :	8%	**Subscriptions rate assessment**		Donations	0 M LBP
Kwh from Gen. :	8%	Volume Produced	53 670 K m^3	Consumables	740 M LBP
EDL increase factor :	1.00	Volume Billed	35 400 K m^3	Paid by WE	680 M LBP
EDZ increase factor :	1.00	Technical losses	8% (ILI = 8)	Donations	60 M LBP
CPI :	115	Subscriptions Rate	71%	O&M	4 637 M LBP
Salaries increase factor :	1.00	Potential invoicing	34 938 M LBP	Paid by WE	4 637 M LBP
Including new WWTPs :	No			Donations	- - M LBP
				Administrative	1 576 M LBP
Tariff increase factor :	1.00	(Avg. bill amount : 271 000 LBP)			

2022

Operational Revenues : 24 965 M LBP		Cash Flow : 10 288 M LBP		Total OPEX : 224 791 M LBP	
Financial Indicators (Typical 2022)		**Collection rate assessment**		**OPEX Breakdown**	
Exchange Rate (base = 1 500) :	20 000 LBP/USD	Invoiced :	24 965 M LBP	HR	22 094 M LBP
Fuel (base = 850) :	19 700 LBP/l	Collected :	10 288 M LBP	Power	123 371 M LBP
Gazoline (base = 25 000) :	375 000 LBP/20 l	Collection Rate	41%	EDL	82 468 M LBP
Transportation (base = 8 000) :	64 000 LBP/day	Cost recovery	5%	EDZ	22 460 M LBP
Kwh from EDL (base = 84%) :	84%			Generators	18 442 M LBP
Kwh from EDZ (base = 8%) :	8%	**Subscriptions rate assessment**		Donations	0 M LBP
Kwh from Gen. (base = 8%) :	8%	Volume Produced	53 670 K m^3	Consumables	10 066 M LBP
EDL increase factor :	13.00	Volume Billed	35 400 K m^3	Paid by WE	10 006 M LBP
EDZ increase factor :	20.00	Technical losses	8% (ILI = 8)	Donations	60 M LBP
CPI (base = 115) :	700	Subscriptions Rate	71%	O&M	59 666 M LBP
Salaries increase factor :	2.00	Potential invoicing	34 938 M LBP	Paid by WE	59 666 M LBP
Including new WWTPs :	Yes			Donations	- - M LBP
				Administrative	9 594 M LBP
Tariff increase factor :	1.00	(Avg. bill amount : 271 000 LBP)			

A.4.4 BILLING, COLLECTION, SUBSCRIBERS

Such situation is not sustainable and must be addressed urgently. Increasing subscribers, billing and collection rates is one of the key tools for enhancing the revenue base of the WE to achieve financial viability, and sustainability; in fact, the benefits of efficient billing and collection practices are almost instant and can improve the revenue accounts immediately.

The data shows a steady but limited growth in the number of subscribers, between 1 and 5% a year, that is tied to average population growth, and increasing upon new project implementation

A.5 KEY RECOMMENDATIONS

The outcome of the Performance Diagnosis is the basis for identifying required action to gradually improve the WE's performance in order to bring the services provided and the financial sustainability up to acceptable standards.

Strategic goals to be achieved are :

- Improve the organization structure and staffing of the water establishment.
- Reduce the non-revenue water and water losses
- Promote the efficient use of energy to reduce the consumption and improve cost recovery
- Establish a comprehensive O&M system to maintain the existing water infrastructures and their associated equipment and construct new water systems, where needed, to improve the quality of service, reduce the O&M cost and increase the service coverage
- Set up a monitoring and audit system to improve the quality of service.

Under Section A.5,*Main findings and recommendations*, key recommendations are given for each topic separately.

In this SectionA.5, key recommendations are grouped and sorted by priority.

A.5.1 MASTER PLAN / STRATEGY

BWE master plan needs to be updated, including a cost benefit analysis for capital investment projects needed in the short term, considering the impact of the new developments on the status of the WE's human resources and the ability to implement the set targets. Possible blockages in projects' implementation due to self-proclaimed water rights is a serious issue that needs to be taken into consideration when drafting any Master Plan

Estimated duration: 24 Months

A.5.2 ORGANIZATION STRUCTURE AND STAFFING

To improve the organization structure and staff's performance, it is recommended to:

- Assess the pertinence of the present Organisation Chart in light of today's challenges the WE is facing, mainly but not only in the fields of wastewater, data acquisition and processing, water quality, and else; in addition to the fields of management and development
  Propose a new Organization Chart in line with the above, including job description and qualification requirements for each staff member down to the level of first line supervisors
- Set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.

- Initiate necessary legal steps in order to implement this new organisation chart, and to allow the WE to fill in the vacant positions.
- Identify staff capacity building needs and set up an adequate training program to bring staff's performance to a satisfactory level in terms of the services to provide.

A.5.3 DIGITALISATION

The various data, whether financial or technical should be centralized in one data centre or digital platform, therefore it is necessary to:

- Carry out an assessment of all data acquisition/processing systems in use at the WE and design a new data centre, to be implemented by steps, in the view of a central digitalization system for the whole WE. Based on the outcome of this assessment, the below steps would be carried out, in all or partially.
- Carry out studies for the improvement/replacement - if deemed necessary - of the existing ERP system, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the improvement and eventual extension of the existing GIS system to cover the acquisition of all technical data, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the design of a data acquisition and processing system to cover the monitoring and management of the production and distribution flows; with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building. Supply and installation of the required remote sensors for the operation of the systems shall not be part of these Tender Documents.
- Implementation of the digitalization system.

A.5.4 WATER PRODUCTION – AVAILABLE WATER RESOURCES

Presently, the water production is not adequately monitored as the current SCADA system does not cover all the facilities, and does not produce comprehensive reports; the production figures provided by BWE are based on operators' *best estimate*.

Therefore, it is necessary to:

- Carry out a general survey of all water sources presently in service; assess the status of the existing flow measurement equipment if any;
- Prepare Tender Documents for the implementation of flow/yield measurement equipment on all water sources, linked to the central production data centre.

Because the cost for installing measurement equipment on all the water sources presently in service is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

A.5.5 WATER DISTRIBUTION

Here again, the distributed flow provided by the WE is an operator's *best estimate*, due to the lack of flow measurement at the level of the distribution centres or reservoirs.

Therefore, it is necessary to:

- Carry out a general survey of all distribution zones and identify the feeding point(s) of each, and assess the status of the existing flow measurement equipment at each feeding point, if any
- Prepare Tender Documents for the implementation of flow/consumption measurement equipment on each supply point of each distribution zone, linked to the central production data centre.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.
- Identify existing DMAs and/or areas that could possibly be turned into DMAs, and identify possible locations for the installation of bulk flow/consumption meters on the distribution network, linked to the central production data centre; and prepare Tender Documents for the supply and installation of such equipment.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

A.5.6 PILOT DMA

Identify, in close coordination with the WE, one pilot area to convert into DMA and carry out within this area detailed studies for:

- Detailed customer census in order to assess the consumption needs and its geographic distribution.
- Detailed distribution network survey followed by a hydraulic modelling exercise.
- Installation of bulk flow meters on strategic locations, and water meters on a number of house connections (if not all).
- Assessing the water losses.

A.5.7 NON REVENUE WATER

The lack of data coupled with absence of DMAs impacted the accuracy and quality of the NRW results. Given this finding, the following actions are recommended:

- Implement low cost high impact intervention, the so-called “quick wins” typically the commercial/apparent loss reduction measures instead of the more capital-intensive reduction measures targeting the physical/real loss. The activities consist of customer database update through door-to-door surveys to identify illegal practices, leaks on the service connections, and improved meter management, …
- Implement DMAs for demonstration and trial purposes. The DMAs are used as a diagnostic tool in quantifying physical losses (through bottom-up assessment), and to validate the results of the NRW assessment (top-down assessment).
- Prepare a NRW Reduction Strategy/Plan based on pilot projects outcome and set the NRW targets with the required budget.
- Promote the NRW problem ownership and introduce organizational measures such as working groups, NRW units to boost the implementation capacity.

A.5.8 BILLING AND COLLECTION

The benefits of efficient billing and collection practices are immediate and can quickly improve the revenue accounts.

Based on the outcome of the present assessment, the below actions are recommended:

- Conduct a study to assess the weak collection efficiency and the inadequate customer records with focus on the reliance on contractual collectors (contract terms, remuneration, number of collectors and performance targets)
- Carry out studies for the assessment of the existing billing and payment processing system and the possibility of the introduction of improved billing technologies, with the view of future integration within a central digitalization system.
- Strengthen the geographic information system mapping to cover the subscribers’ data and the records of properties showing all potential water customers.

A.5.9 TARIFF STUDIES

Tariffs in force are deemed to cover WE's costs including Opex, Capex, and asset depreciation. With the present tariff in force, this is far out of reach.

Therefore, it is recommended to:

- Undertake an economic analysis of production and cost, taking into consideration the short-run and long-run to allow for a comprehensive pricing strategy that would allow to gradually recover the operational costs and eventually any future capacity expansion.

- Establish a tariff setting scheme and tariff reforms with mechanisms for obtaining the information on present and future costs of operation and mechanisms of indexation to adjust tariffs by inflation, energy prices and other items that are part of the cost schedule of BWE.

A.5.10 O&M MANAGEMENT SYSTEM

In order to enhance efficiency and reduce the cost of O&M, it is necessary to design a modern preventive/corrective maintenance system, and implement it in the view of central digitalization system for the whole WE.

A.5.11 PRODUCTION COST OPTIMISATION.

With the present financial situation, energy has become the major component of production cost, nearing 56 % (Figure A 4-1 above). BWE's strategy is to implement renewable energy sources such as hydroelectric or solar, in addition to shifting from underground to surface water sources, where possible. However, there is no comprehensive view of the subject.

Therefore, it is necessary to carry out a general *Cost Optimisation Master Plan* covering in details all the available options over the WE's jurisdiction, and setting up the upper threshold of what could be possibly achieved in this field.

A.5.12 TAKING OVER THE WASTEWATER SECTOR

BWE is unable to bear the cost of operating its waste water treatment plants, so financing must be provided from other sources (GoL or donors) to:

- Outsource the operation and maintenance of each treatment plant and related network to private operators via performance-based contracts.
- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts

A.5.13 SHIFTING TO METERED CONSUMPTION POLICY

Metered consumption is key for reducing NRW, Opex, and overall water consumption. Currently installed water meters across the Beqaa are not read, and are billed at flat rate.

However, based on lessons learned from past experiences, it appears that this is not a top priority and a number of prerequisites are to be implemented before systematically installing water meters, out of which:

- Setting up a team to operate and manage meters’ maintenance and reading.
- Selecting the most adequate meter type based on the adopted reading policy.
- Securing continuous supply in the areas where the meters shall be installed, in order to encourage the consumers to subscribe and accept the idea of water metering.

Water metering projects may be systematically implemented over the whole jurisdiction once the above is implemented and running smooth.

SECTION B
TECHNICAL PERFORMANCE DIAGNOSIS

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B. 1 HUMAN RESOURCES

The assessment of personnel investigates the quantitative sufficiency of different criteria of education and specialisations within the establishment. This assessment considers the current case of Lebanon where hiring and firing have been severely restricted and external contracts have been made to cover not only daily labour but vital positions.

Moreover, it is important to assess the validity of the imposed organisational regulations that specify the number and type of employee for the WE and area of business and show irregularities in that design that currently limits the WE even if hiring was within their ability.

B. 1.1 Total personnel

The main reference for the preferred number of staff comes from Tynan and Kingdom where the best performing quartile of water utilities measured 5 employees per 1000 service connection or fewer. The figure cannot be generalised easily given issues such as:

- The number of connections is not an applicable basis for assessing performance since some activities such as water distribution may be related to the number of connections, but others such has customer service, meter reading, and door-step collection may not. That and with the case of Lebanon a connection often serves an apartment or office building with multiple units.
- The figure does not consider the method of billing and collection where in some countries the process is done over the mail or using the internet while in others, such as the case of Lebanon and much of the region, billing and collection is primarily done in the field with company staff personally interacting with most customers.
- Moreover, the number needed to operate and manage the processes related to customer billing and metering would be different depending on the length of a billing cycle, where a monthly cycle would require more than an annual cycle.
- Also of great relevance is the relative number and distribution of resources, where in some utilities production and transmission facilities are few and centralised, while in others, such as in Lebanese WEs, the resources are many and often localised.

Those and more objections can be drawn, and therefore it was our attempt to focus on the sufficiency of staff for each business area and job type instead, as will be shown next. To assess the total number of staff we took the following:

- The total number as per the WE organisation by-laws.
- The number of employees.
- The number of contracted staff.
- The total number of staff whether contracted or employed.

First, we look at a faithful demonstration based on an estimate of the number of connections done for the WE. The exact or even approximate number of connections is not known. The number of connections here refer to the total number of supposed tapping points on the network, or approximately the total number of buildings connected to the network. That number does not correspond to either legal tapping points or the number of official subscribers that is estimated for the WE.

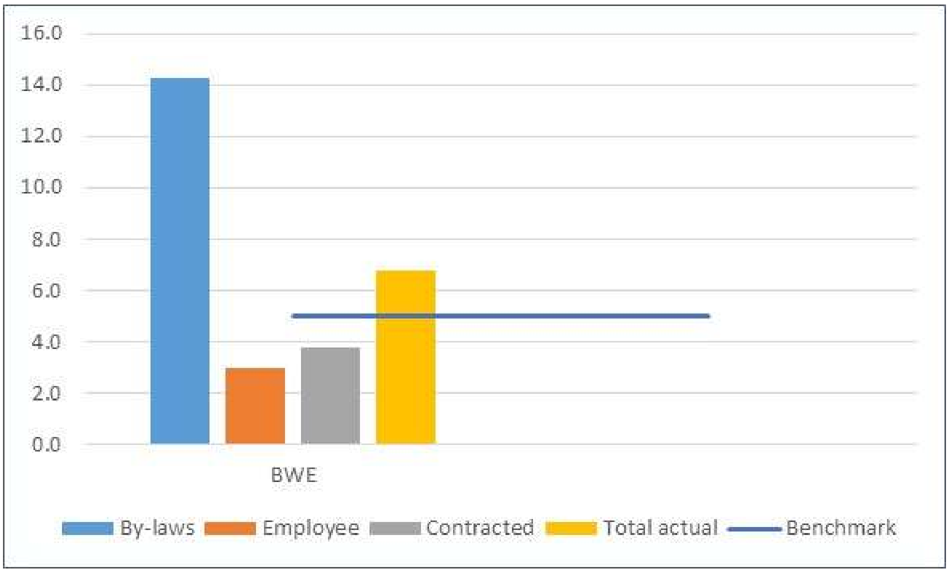

Figure B 1-1 Personnel per 1000 connections.

Acknowledging that the estimated number of connections is prone to a large uncertainty, it can clearly be seen that using the number of connections as a base indicator may not be the best in the case of Lebanon and using the number of subscribers therefore would be more representative of the idea behind such indicator. Using the number of subscribed customers instead, we can find that for the case of BWE the total current staff is below the benchmark, yet the number assigned by the by-laws exceeds and is about double that of the benchmark. That would indicate that the number of decreed staff in this WE has been exaggerated.

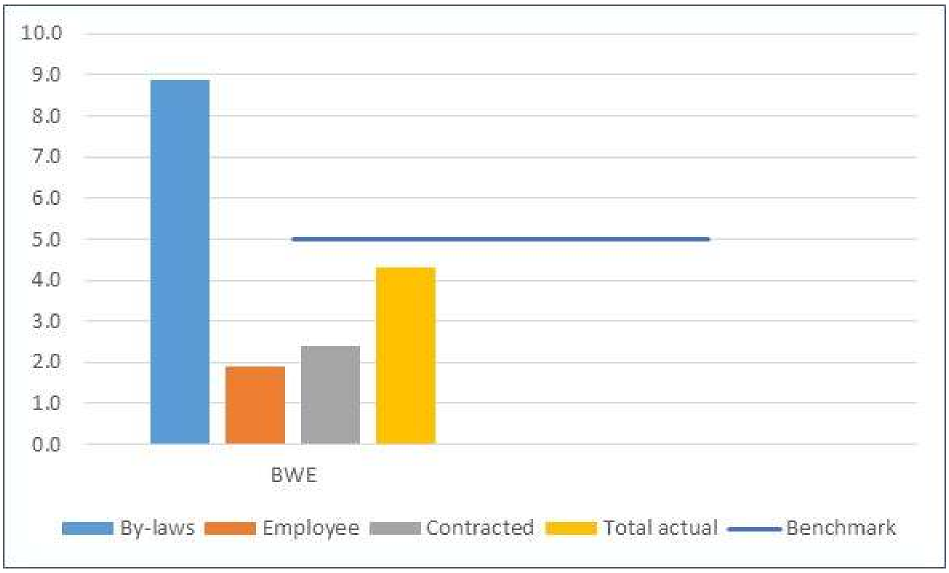

Figure B 1-2 Personnel per 1000 subscribers.

Acknowledging that the number of subscribers does not represent the service area, and accounting for the number of illegal users, the previous conclusion could therefore be misleading. For assessing the total number of potential subscribers, we would use the number of units within the service area as demonstrated below. Working out better estimates would be a priority in many areas of analysis and planning.

Table B 1-1 Approximate system size assumptions used.

Variable	Unit	BWE
Connections	1000 No.	55
Subscribers	1000 No.	88
Units	1000 No.	220
% Subscribed	%	40%
Implied population	M No.	1.1

Using the number of units instead of the number of current customers a clearer picture is formed, and the decreed number of staff for BWE would fall within the benchmark.

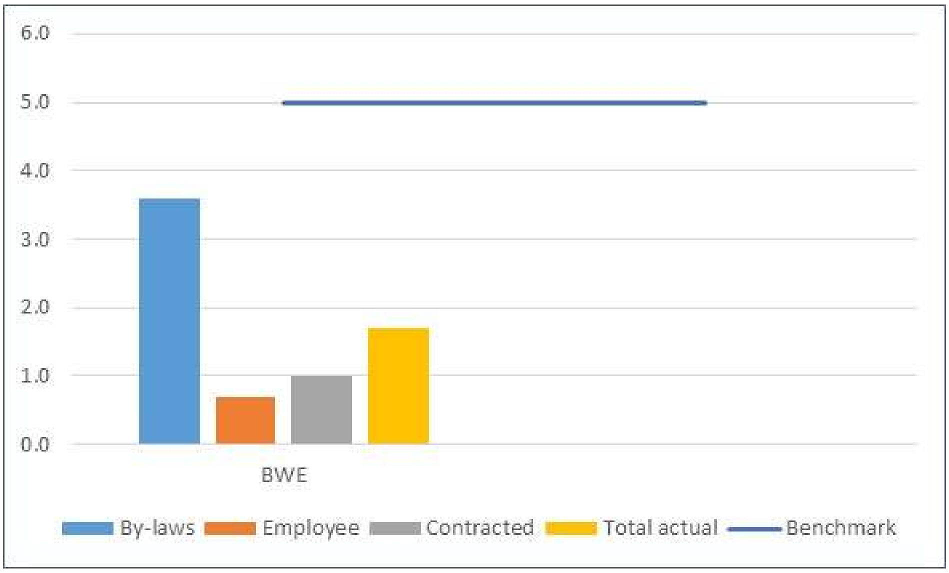

Figure B 1-3 Personnel per 1000 units or potential subscriber.

Another indicator used for sizing the total utility staff is related to the quantity produced.

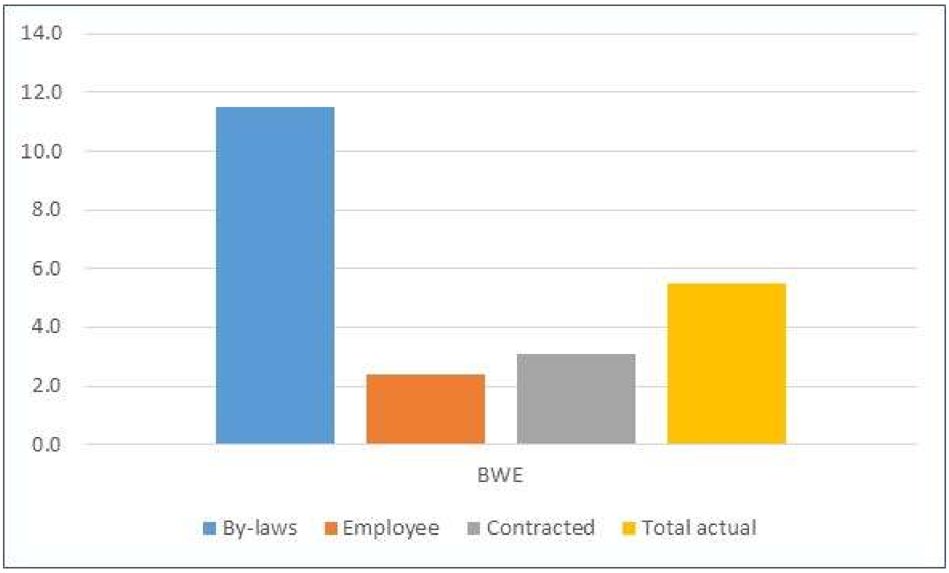

Figure B 1-4 BWE - Personnel per 1,000,000 m^3 produced.

The comparison with the other WEs shows a similar trend where the decreed staff of BWE and NLWE according to the by-laws relatively exceed those of BMLWE and SLWE. However, and according to this indicator, the actual total number of staff is proportionate in all WEs.

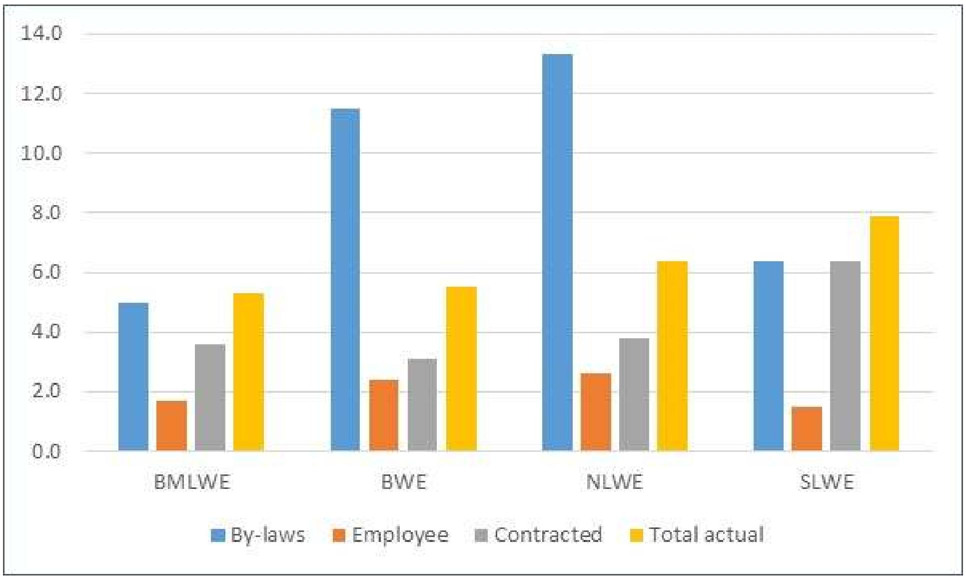

Figure B 1-5 Compared Personnel per 1,000,000 cubic meters produced.

Table B 1-2 Total personnel performance indicators.

Performance indicator	Unit	BWE	Benchmark
Employees per connection	No./1000 Connections	14.3	5 (Tynan and kingdom 2002)
		3.0	
		3.8	
		6.8	
Employees per customer	No./1000 Customer	8.9	5 drawing from Y&K 2002
		1.9	
		2.4	
		4.3	
Employees per customer	No./1000 Units	3.6	5 drawing from Y&K 2002
		0.7	
		1.0	
		1.7	
Employees per water produced	No./(10^6 m^3)	11.5	Comparative
		2.4	
		3.1	
		5.5	

B. 1.2 Personnel business area

Looking at the distribution of personnel by department, and using the concept of business areas, we find that the organisation by-laws has the following features:

- Customer services is a central unit.
- No wastewater management units in BWE.

- Structure is flat and simple in BWE.
- Stores units does not have a financial counterpart in BWE.

And so on. Also looking at the number of staff under units of each business area we can see the large discrepancy.

Table B 1-3 Personnel according to the by-laws

under units of different business areas.

Variable	Unit	BWE
Customer service units	No.	6
Distribution units	No.	553
Engineering units	No.	10
Facility units	No.	88
Finance units	No.	53
General units	No.	49
HR units	No.	14
Water quality units	No.	11

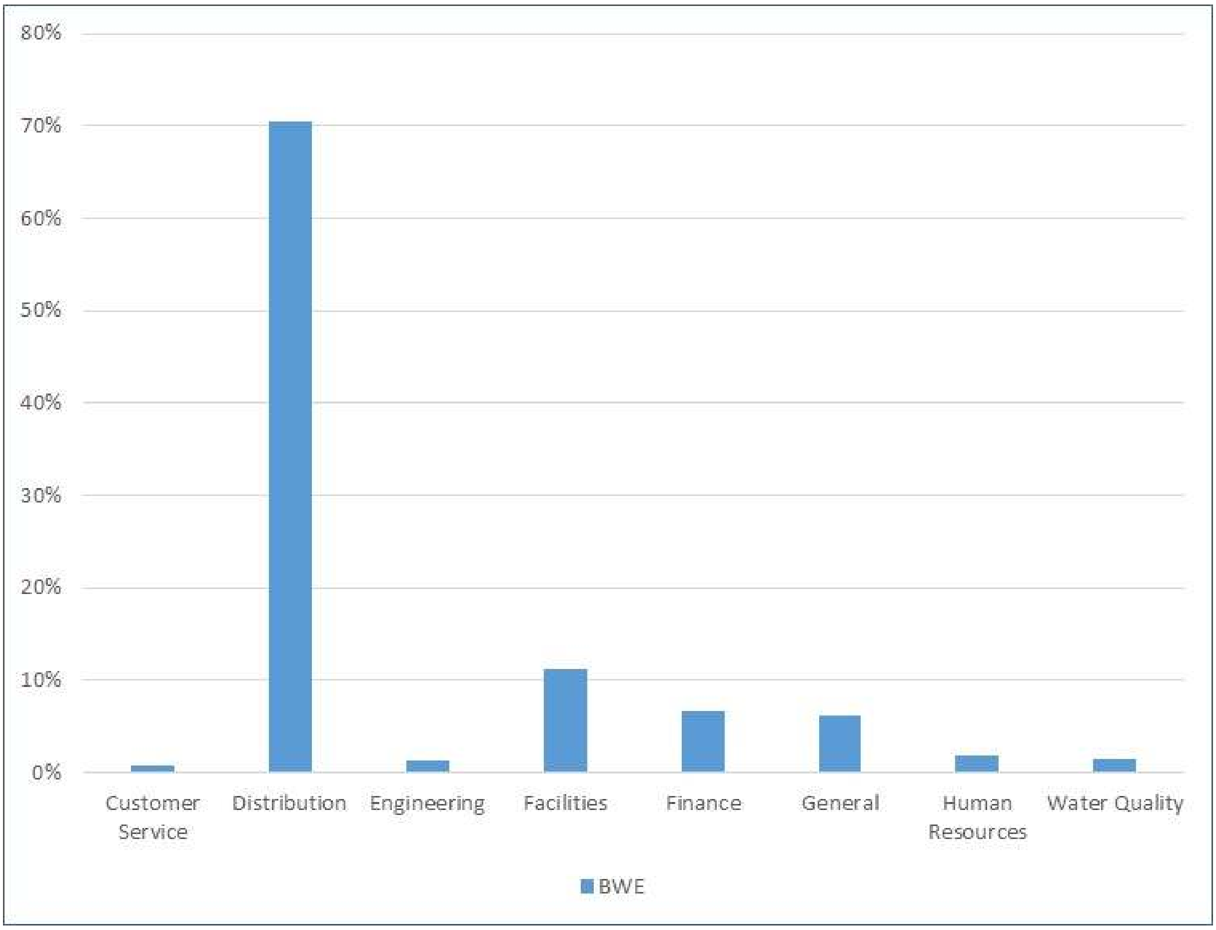

Figure B 1-6 Personnel according to the by-laws *under units of different business areas.*

To better be able to judge the efficacy of the distribution, we look at the distribution business which usually includes most of the following:

- Operation of water distribution.
- Maintenance of distribution networks and service connections.
- Implementation or overseeing new connections.
- Water loss management.
- Local customer services, metering, and collection.
- Local store management.

And the facilities business, usually includes production, treatment, and transmission operation and maintenance. In most cases also includes water quality labs.

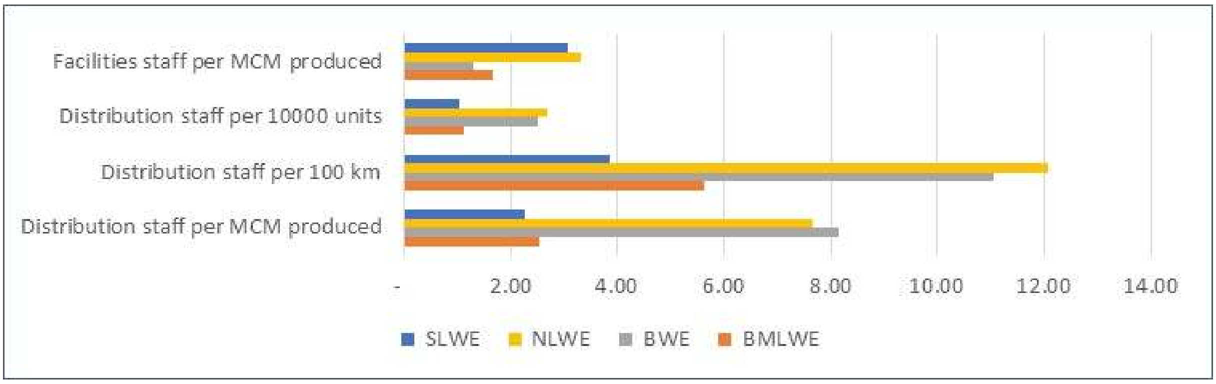

Figure B 1-7 Facilities and distribution personnel performance

according to the by-laws under units of different business areas.

The comparison of the four WEs according to facilities and distribution personnel performance shows disparities in the number of staff of the four WEs, which promotes the need to revise the organization structure by specialists.

B. 1.3 Personnel job type

We attempted to look at the distribution of current employees and contracted staff by job type, especially since it shows where the WEs are being challenged the most and which positions are the most critical. This is limited by the freedom of the WE to choose adequately and therefore should only be seen in terms of general patterns. Moreover,the analysis is also limited by the availability of information, as detailed information of permanent staff and their current jobs was made available by BWE, information for contracted staff was incomplete . Therefore, we shall concentrate the effort on the available information found in the by-laws as follows:

Table B 1-4 Personnel by job type according to the by-laws.

Variable	Unit	BWE
Auxiliary - Clerical	No.	67
Auxiliary - Driver	No.	28
Auxiliary - Guard	No.	0
Auxiliary - Office boy	No.	35
Collector/Reader	No.	55
Customer service	No.	22
Financial/Administrative	No.	81
Management	No.	31
Management (Eng.)	No.	24
Technical - Driver	No.	22
Technical - Engineer	No.	5
Technical - laborer	No.	209
Technical - Other	No.	177
Technical - Water quality	No.	28

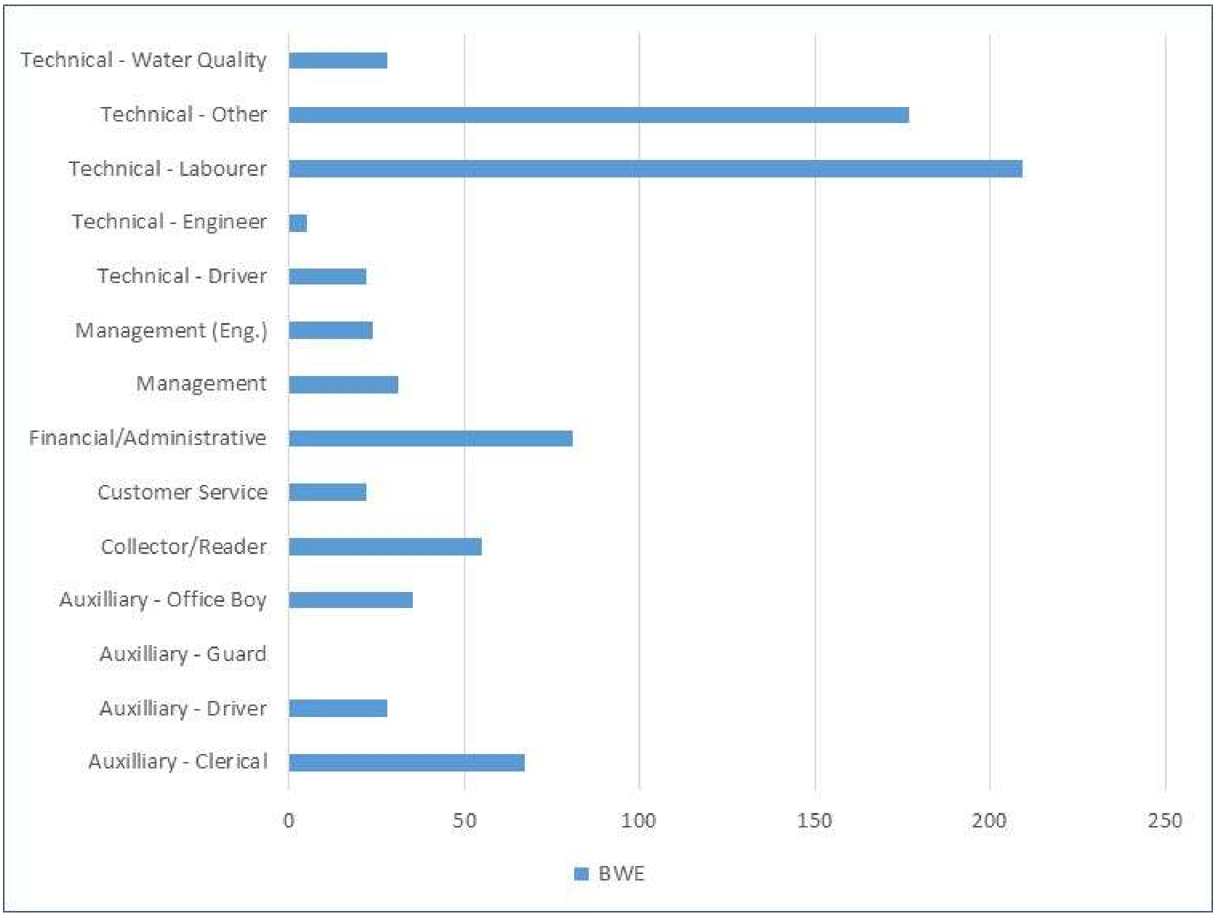

Figure B 1-8 Personnel by job type according to the by-laws.

To calculate the percentage of each job type.

Table B 1-5 Relative number of each job type according to the by-laws.

Relative size	Unit	BWE
Auxiliary - Clerical	%	9%
Auxiliary - Driver	%	4%
Auxiliary - Guard	%	0%
Auxiliary - Office boy	%	4%
Collector/Reader	%	7%
Customer service	%	3%
Financial/Administrative	%	10%
Management	%	4%
Management (Eng.)	%	3%
Technical - Driver	%	3%
Technical - Engineer	%	1%
Technical - Laborer	%	27%
Technical - Other	%	23%
Technical - Water quality	%	4%

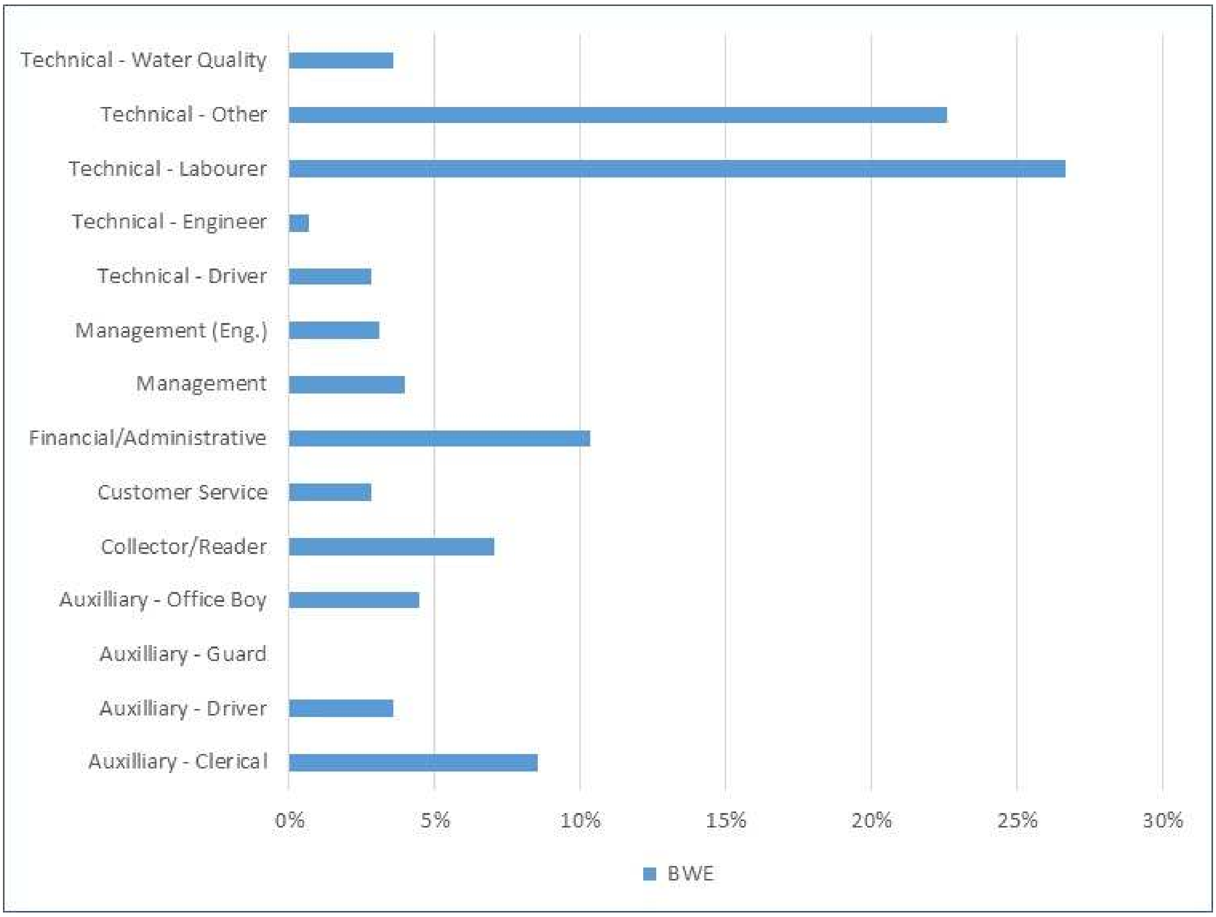

Figure B 1-9 Relative number of each job type according to the by-laws.

While BWE is needing and indeed contracting guards, its organisation diagram is void of them. In the case of BWE, and given the accurate HR data provided, we can compare the job types from the by-laws with the actual employed and contracted numbers.

Table B 1-6 Number of personnel decreed and actual for different job types in BWE.

Variable	Unit	By-laws	Employee	Contracted	Total
Auxiliary - Clerical	No.	67	7	9	16
Auxiliary - Driver	No.	28	1	2	3
Auxiliary - Guard	No.	0	5	3	8
Auxiliary - Office boy	No.	35	2	1	3
Collector/Reader	No.	55	25	10	35
Customer service	No.	22	2	0	2
Financial/Administrative	No.	81	14	13	27
Management	No.	31	38	0	38
Management (Eng.)	No.	24	1	0	1
Technical - Driver	No.	22	0	0	0
Technical - Engineer	No.	5	0	10	10
Technical - Laborer	No.	209	35	92	127
Technical - Other	No.	177	33	65	98
Technical - Water quality	No.	28	1	5	6
Total	No.	784	164	210	374

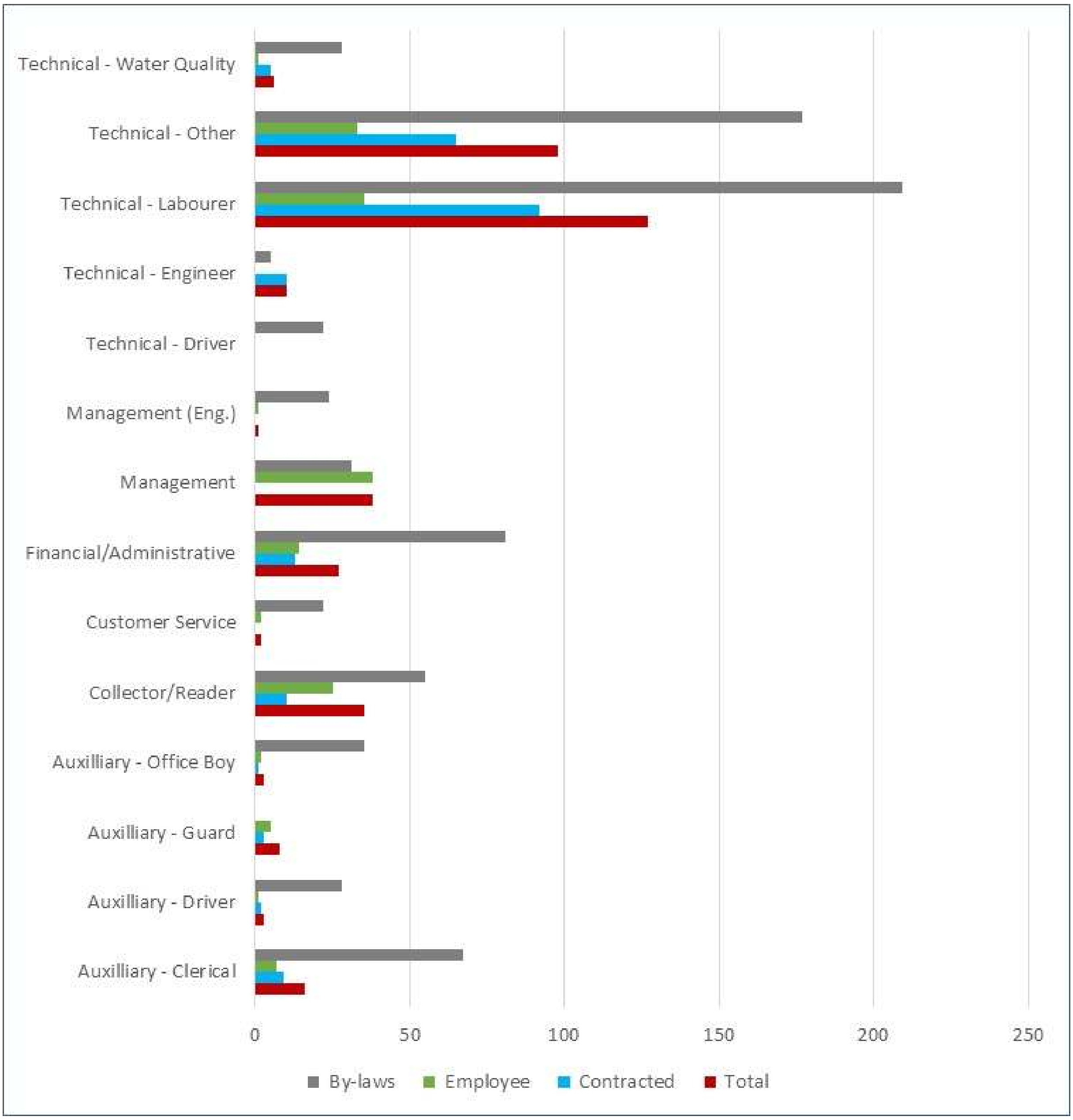

Figure B 1-10 Number of personnel decreed v/s actual for different job types in BWE.

It can be clearly seen in the case of BWE that the technical needs of the establishment in terms of technicians and labourers have outweighed those of hiring clerks and drivers. The apparent discrepancy in the number of management personnel is due to engineering management roles being assigned to non-engineers.

Looking back at the by-laws, we can look at specific areas of interest for improved water supply service performance for the four WEs. Looking at the customer service staff for each WE, here including clerical staff or otherwise involved in customer service office work, as well as the number of collectors and meter readers, we can see the discrepancy between the number of staff expected to perform these duties and the number of customers.

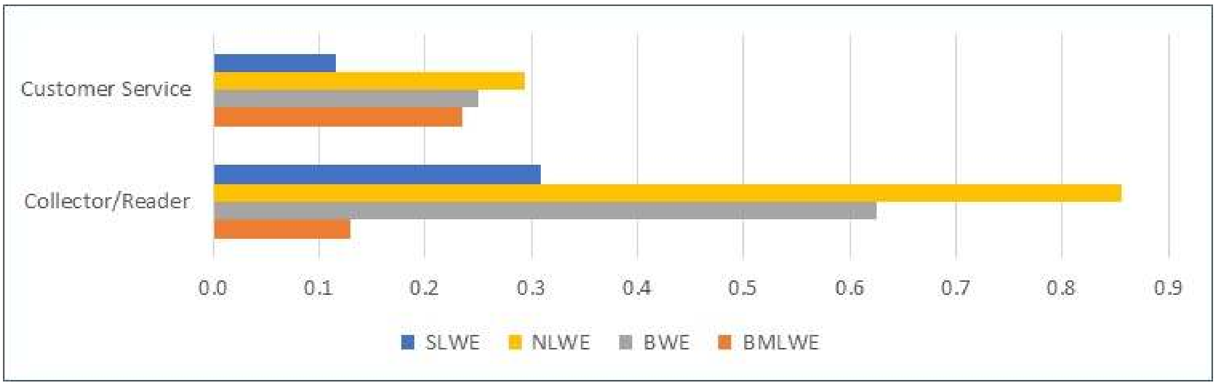

Figure B 1-11 Number of customer service and collection/meter reading staff according to the by-laws per 1000 current subscribers.

The same issue can be seen when using the number of units, or the potential number of customers, and to a larger extent.

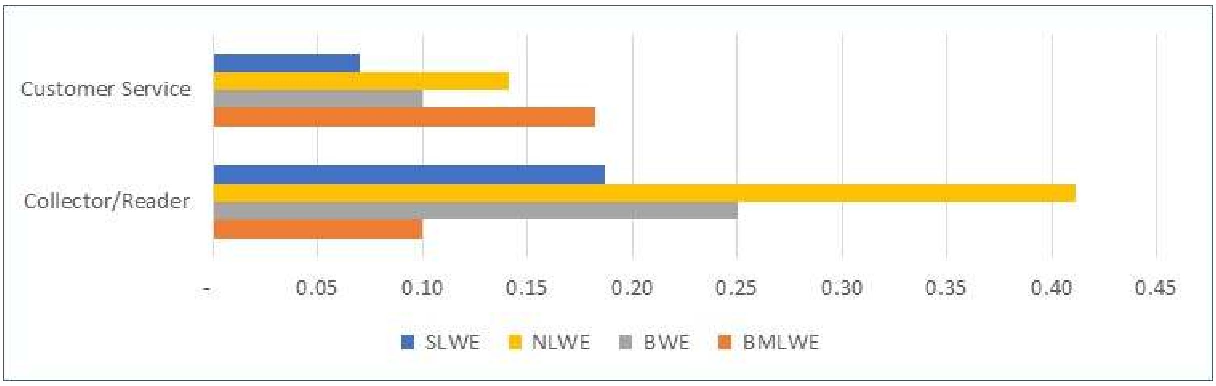

Figure B 1-12 The number of customer service and collection/meter reading staff according to the by-laws per 1000 units or potential customer.

Similarly, for technical job types including engineering management, dividing the number of staff according to the by-laws by the number of units or the water produced leads to different results for each WE.

Figure B 1-13 The number of technical staff

according to the by-laws per 1000 units and million cubic meter produce.

B. 1.4 Personnel education level

Except for few cases where the title includes the terms “engineer” or “graduate”, the organisational diagram does not specify the education level of employees. The education levels for employees and contracted staff were gathered, interpreted, or estimated based on the available data.

Table B 1-7 Number of personnel by education.

Variable	Unit	Type	BWE
University degree personnel	No.	Employee	25
Basic education personnel	No.		36
Other qualification personnel	No.		103
Unknown	No.		-
University degree personnel	No.	Contracted	44
Basic education personnel	No.		27
Other qualification personnel	No.		139
Unknown	No.		-
University degree personnel	No.	Total	69
Basic education personnel	No.		63
Other qualification personnel	No.		242
Unknown	No.		-

Looking at the latest staff information, there is a varying level of education that cannot be interpreted positively or negatively without setting clear job descriptions and minimum required qualifications. This and the need for transparency stress the need for clear hiring criteria and job descriptions.

Table B 1-8 Performance indicators of personnel education.

Variable	Unit	Type	BWE
University degree personnel	%	Employee	15%
Basic education personnel	%		22%
Other qualification personnel	%		63%
Unknown	%		0%
University degree personnel	%	Contracted	21%
Basic education personnel	%		13%
Other qualification personnel	%		66%
Unknown	%		0%
University degree personnel	%	Total	18%
Basic education personnel	%		17%
Other qualification personnel	%		65%
Unknown	%		0%

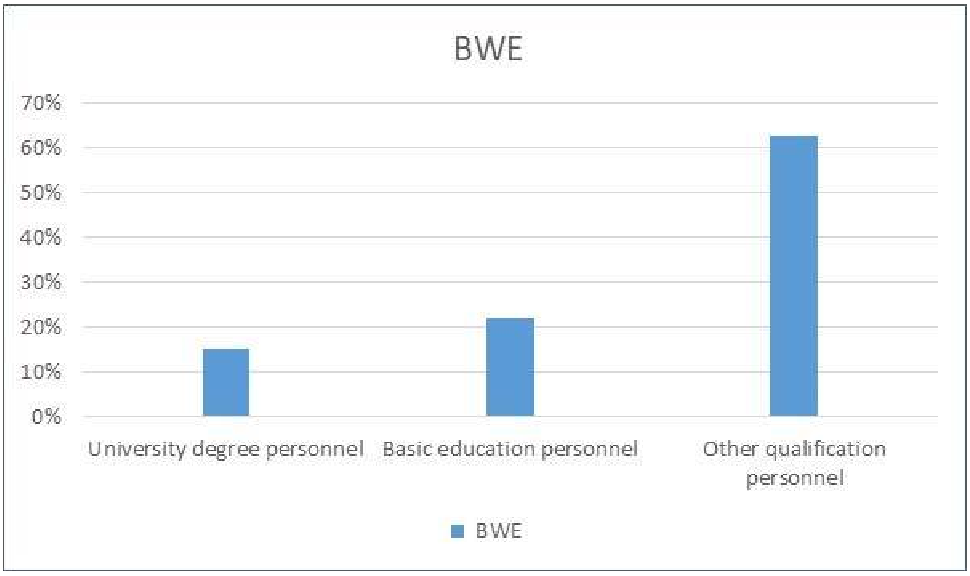

Figure B 1-14 Education level of employees.

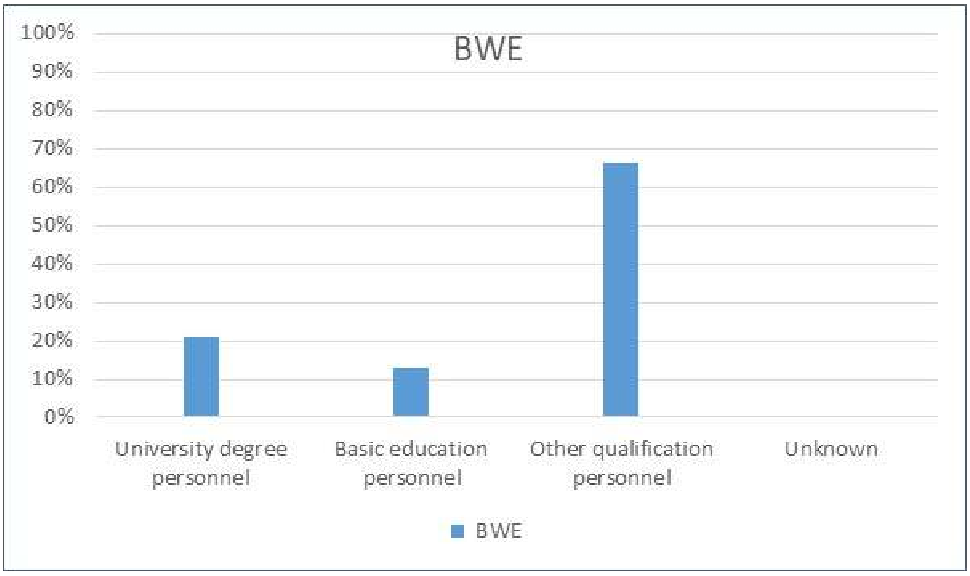

Figure B 1-15 Education level of contracted staff.

B. 1.5 Training

No data in relation with the total number of training hours is delivered to the TA from BWE.

Table B 1-9 Training variables.

Variable	Unit	Type	BWE
Training	Hours/employee	Employee	

Table B 1-10 Training performance indicators.

Variable	Unit	Type	BWE
Training	Hours/employee	Employee	

B. 1.6 Employee health and productivity

The absenteeism variables are taken from the BWE annual report of 2016. Other than that, no information was provided.

Table B 1-11 Training performance indicators.

Variable	Unit	BWE
Working accidents	No.	
Absenteeism	days	3034
Absenteeism due to accidents or illness at work	days	656
Absenteeism due to other reasons	days	2378
Overtime work	hours	

The indicators were calculated based on the total number of employees of 2016 which was 212.

Table B 1-12 Employee health and productivity performance indicators.

Variable	Unit	BWE
Working accidents	No./100 employees	
Absenteeism	days/employee	14
Absenteeism due to accidents or illness at work	days/employee	3
Absenteeism due to other reasons	days/employee	11
Overtime work	%	

It is of great importance to ask the WE to establish a data base in relation with the working accidents and overtime to be able to have a full picture on the productivity of staff.

B. 1.7 Diagnosis of challenges

To assess the factors leading to low performance on in personnel management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths

- Trial and error using on-demand staffing contracts and seconded staff helped provide a better assessment of the needed specialties and number of staff for each.
- ERP system allows the integration of an HR model with the payroll as currently used in BWE.

Weaknesses

- No job descriptions, clear assignment of responsibilities, or clear criteria for health and safety.
- Dysfunctional employee evaluation process.
- No or outdated or insufficient written procedures increase the demand on the knowledge of key staff members.
- Higher level positions assigned to employees without required qualifications.
- Contracted staff expecting a place in a new WE set up.
- The scope of training is often restricted to a few employees due to the age of and positions assigned to employees.
- WE is restricted in investing in personnel improvements given that most functional staff is contracted.
- HR and payroll modules in ERP often generate inaccurate reports

Opportunities • Economically and socially attractive job opportunities. • Technological opportunities in training and distant learning.
Threats • Political environment does not support hiring. • Current by-laws do not support WE in acquiring the needed functions, specialties, and relative number of staff for each.

B. 1.8 Recommended actions

The shape of reformed water establishments translates directly into its organization and its staff. Among the gaps found during the assessment with regard to the by-laws are the following

- A mixture of detailed and generic job descriptions at the level of the organization units, and the complete lack of job descriptions and responsibilities at the level of individual positions.
- Outdated unit job responsibilities that lack sufficient consideration if at all for some of the major functions such as GIS as a central database for assets and subscribers, widespread metering and meter reading, IT system management, central call centre and command centre, among others.
- Little correspondence between the decreed number of staff and the scope of the function.

On the staffing side, major issues have led to the accumulation of hurdles and difficulties for any restructuring attempt. Some of the main issues on the staffing side are:

- With the current restrictions on hiring and firing, there is a high dependence on personnel contracts and donor-funded seconded staff, some of them may not have been able to work at the WE even if the hiring doors were open due to their positions not existing in the by-laws, the number in the by-laws being lower than the actual needs, but most importantly having to qualify through the public hiring system.
- Most leadership positions are filled by assignment and often with personnel that could not have been formally appointed for the positions. Upon restructuring, these individuals may be treated unjustly and may harbour resentment if their service in their assigned roles was ignored. At the same time, most of the cases found cannot possibly find a normal path to qualify to the jobs currently filled by assignment.

To improve the organization structure and staff's performance, it is recommended to:

- Assess the pertinence of the present Organisation Chart in light of today's challenges the WE is facing, mainly but not only in the fields of wastewater, data acquisition and processing, water quality, and else; in addition to the fields of management and development
  Propose a new Organization Chart in line with the above, including job description and qualification requirements for each staff member down to the level of first line supervisors

- Set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.
- Initiate necessary legal steps in order to implement this new organisation chart, and to allow the WE to fill in the vacant positions.
- Identify staff capacity building needs and set up an adequate training program to bring staff's performance to a satisfactory level in terms of the services to provide.

B. 2 WATER LOSS

The procedure for assessing water loss performance is a process that has been developed while inherently considering that the nature of the problem is rife with unknown. However, the challenge posed in Lebanon may stress this procedure beyond its normal shape. The assessment of water loss can proceed in two directions, top-down and bottom-up.

B. 2.1 Top-down assessment

Top-down assessment of water loss starts with the measurement, calculation, and/or estimation of the total water loss using system input water volume and the billed authorized consumption during the period. Secondly, estimations are made for each kind of apparent loss, i.e., customer meter under-registration, unauthorized consumption, and data acquisition and handling errors. Starting with the calculation of the total non-revenue water we have the estimates made in 2020:

Table B 2-1 System input volume calculation, for the year 2020.

Quantity	Unit	BWE
Water produced	m^3	53,670,099
Water imported	m^3	-
Water exported	m^3	-
System input volume	m^3	53,670,099

The net system input is the same as the production estimates since BWE claimed no import or export of potable water across establishment lines. However, and due to the existence of local operating municipalities and comities, this may not be the case. That is since the WE ideally has ownership and responsible for bulk water production throughout its service areas. Such relationship may therefore be seen as that of water export.

The accuracy of the production quantity is uncertain. The production estimates are subject to several issues such as:

- Almost all quantities are based on estimates of production performance and approximate working hours.
- When the source is metered, the meter is often dysfunctional or incorrectly installed.
- When the meter is functional, most readings are not based on regular reading of the source meters but on multiplying the nominal flow by the estimated operating hours.
- The estimates may not consider all sources or update for sources that were dysfunctional a large portion of the duration.
- Most importantly, the extent of each of the problems listed above is neither known nor can be estimated by the WE.

For the BWE, bulk metering is used to an extent, but without similar information, there is no way to verify the level of accuracy without performing an audit and a revision of the estimation of water production based on consistent procedures for:

- Identifying the volumes of metered sources and estimates based on metering.
- Identifying metered quantities based on different meter technologies and conditions.
- Surveying and verifying the readings and flow rates for metered sources.
- Documenting and calculating the hours of operation.
- Assignment of error values and the calculation of the overall accuracy.

Therefore, and given all the unknowns, an estimate of ±20% uncertainty will be used for BWE.

Table B 2-2 System input volume error range at 95%, for the year 2020.

Quantity	Unit	BWE
System input mean volume	m^3	53,670,099
Metered	%	-
Uncertainty	%	20%
Uncertainty	m^3	10,734,020
System input volume min	m^3	42,936,079
System input volume max	m^3	64,404,119

Looking at the billed authorized consumption, the main issue encountered is that metering is not a common practice and the actual water consumed by the customers cannot therefore be known at high accuracy.

Table B 2-3 Quantity billed, for the year 2020.

Quantity	Unit	BWE
Billed authorized consumption	m^3	38,490,126
Billed and metered	m^3	13,482,005
Billed and unmetered	m^3	25,008,121
% quantity "metered"	%	35%
Metered subscribers Avg. consumption for metered	No. m^3/day	33,114 1.12

To alleviate the issue of low customer metering, we looked at the customers labelled as “metered” and the average metered consumption. It must be noted that without an auditing of the metering practices the percentage of actual metering quantities based on real readings cannot be determined.

Moreover, when calculating the average consumption of metered customers, the results can vary from 1 to 7 cubic meters per day. For BWE, as metered are not read, the value corresponds to the average “subscribed” unmetered quantities estimated, depending on locality, yet if assumed to be the actual consumption for the illegal connections and illegal units the result would be greater than the estimated production quantities for BWE.

Table B 2-4 A test of the plausibility of average metered consumption as a representative quantity, for the year 2020.

Quantity	Unit	BWE
Avg. consumption for metered	m^3/day	1.12
Estimated residential units	No.	220,000
Total consumption (test)	m^3	89,570,608
Water produced	m^3	53,670,099
Real losses (test)	m^3	(35,900,508)
Plausibility	m^3	Implausible

In any case, and assuming the production quantities are within the assumed 20% error range, or reasonable, it would also be reasonable to assume that the true average consumption is less that 1 cubic meter per day until better data is available.

This value can be assumed anything from 0.5-1.0 cubic meters per day, with no indicator on where should the average estimate lie. Also, this value could be significantly different to other WEs. This makes the top-down estimate unbalanced. Moreover, this stresses the need to achieve systematic and sufficient knowledge about the actual customer demand and consumption and therefore the extent and type of water loss, the following actions are needed:

- Auditing of metering practices and determination of the extent of using real readings.
- Investigation of the type of subscription and the average consumption for each type such as residential, commercial, etc.
- Collection of a representative sample of temporary customer metering of randomly selected group of unmetered customers using high accuracy static meters.
- Study of metering accuracy and issues faced such as meter aging, air, and intermittent supply by the temporary installation of using high accuracy static meters in series.
- Collection of municipal registration numbers for different units for each region and conducting a study on the extent of unauthorized consumption.

B. 2.2 Bottom-up assessment

Attempting to tackle the issue from the other direction, we ought to visit the different factors used for understanding real losses, mainly leakage, and specifically in the local context.

B. 2.2.1 Estimation of real losses based on DMAs field measurements

The bottom-up estimate of real losses is ideally conducted at the level of a District Metered Area (DMA), where the night flowrates provide an estimate of night leakage, and the different pressure values help find the average daily leakage. However, this may not be applicable to the local context because:

1. Continuously supplied DMAs only exist in a few areas in Lebanon that are far from being representative.
2. Assuming that night flowrates do reflect leakage rates because there is no water consumption at the consumers' level may not be correct in the absence of continuous supply. Due to water rationing, the individual water tanks in each and every house in Lebanon may not be full at dusk because of water cut-offs during the day, and fill up through night time water supply.

In any case, real losses estimation based on field investigation at the level of DMAs are not available in Lebanon. It is therefore necessary to resort to another method to estimate these losses.

B. 2.2.2 Estimation of real losses based on leakage indicators

IWA approach to real losses calculation based on plausible ranges of leakage indicators, is as follows :

$$\textit{Real loss} = \textit{UARL} \times \textit{ILI}$$

Where : *Real Loss* is the volume of water lost per year
UARL is the Unavoidable Annual Real Loss indicator
ILI is the Infrastructure Leakage Indicator

2.2.2.1 Calculating the UARL volume

The UARL volume is given by the following formula :

$$\textit{UARL (l/d)} = P \times (18 \times Lm + 0.8 \times Nc + 25 \times Lp)$$ [1]

Where : P = Average operating pressure.
Lm = Length of main, in Km.
Nc = Total number of connections
Lp = Total lengths from property limit to private gauge/meter, in m
For Lebanon, it is considered that Lp = 0 as all gauges/meters are close to the property limit.

The average operating pressure requires local throttling to ensure higher areas receive water. Network topographies are steep and elevation differences may often reach and exceed the recommended limits of 50 – 70 meters, therefore causing large pressure variations. The average pressure at any given point is estimated at between 30±5 meters as a rough

[1] *Source : IWA*

estimation at one standard deviation, or 30±10 m at 95% confidence limit. Therefore, an average value of ***P = 30 m*** will be adopted for the calculation.

The length of main, as obtained from BWE's GIS system is ***LM = 5 000 km.*** Due to missing as built drawings of some executed projects the length, of main on the GIS system doesn't reflect the actual measurement in the field. There we have taken 5000 km as realistic number for our study.

The number of service connections is calculated based on the estimated total number of housing units within the jurisdiction of BWE (220 000) and the estimated number of connections per housing unit (4), which gives a ***Nc = 55 000.***

Therefore, the UARL can be calculated as follows:

- Average pressure 30 m
- Length of mains 5 000 km
- № of connections 55 000

UARL = 4 020 m³/day
UARL = 1 467 300 m³/year

2.2.2.2 Estimating the Infrastructure Leakage Indicator (ILI)

The ILI is the choice indicator for real loss benchmarking and making comparisons due to its high sensitivity to performance and low sensitivity to local conditions. It is still impossible to guess the ILI without real data. It has a defined lower limit of 1 and considered ideal for developing countries at 2, which means that the actual real losses are twice the UARL.

Figure B 3-1 shows average values of ILI for a number of cities in Europe and Australia, ranging from 1 to 10. As a comparison, the ILI values of some utilities in the Balkan, as given by the *Leaks Suite Library*, range from around 4 to 19.

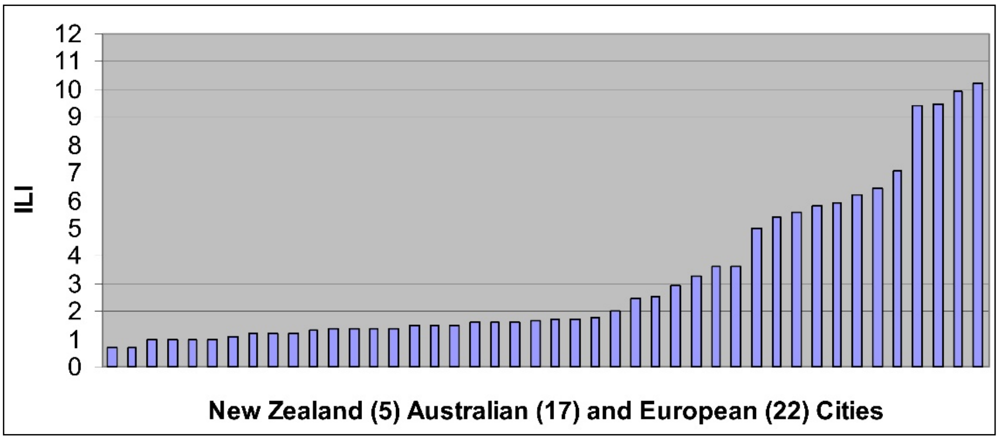

Figure B 2-1 Average ILI values for various cities[2]

[2] *Source: A. Lambert & R. Mckenzie.*

In the case of Lebanon in general, given that networks' material is mostly Ductile Iron or HDPE, with low leakage risk, and given the intermittent water supply conditions coupled to the financial situation the WEs are facing, an ***ILI of 8*** is a plausible as a general assumption at this stage.

2.2.2.3 Calculating the Real Losses

Based on the above, the Real Losses are calculated as follows:

Real losses = UARL x ILI = 1 467 300 x 8 = 11 738 400 m³/year

The above is for a 24h continuous supply, which isn't the case. Assuming a 10 hours supply per day, we have:

UARL for 10 hours supply per day: 11 738 400 x 10 / 24 = 4 891 000 m³/year

The yearly production of BWE being 53,670,099 m³ the real losses amount to 9% of the production.

Assuming supply is continuous, the losses per connection would approximately be 600 to 700 l/connection/day. Referring to Figure B 3-2, and for 30 meters of pressure, the performance is at level D, which is plausible.

Technical Performance Category		ILI	Litres/connection/day (when the system is pressurised) at an average pressure of:				
			10 m	20 m	30 m	40 m	50 m
Developed Countries	A	1 - 2		< 50	< 75	< 100	< 125
	B	2 - 4		50-100	75-150	100-200	125-250
	C	4 - 8		100-200	150-300	200-400	250-500
	D	> 8		> 200	> 300	> 400	> 500
Developing Countries	A	1 – 4	< 50	< 100	< 150	< 200	< 250
	B	4 – 8	50-100	100-200	150-300	200-400	250-500
	C	8 - 16	100-200	200-400	300-600	400-800	500-1000
	D	> 16	> 200	> 400	> 600	> 800	> 1000

Figure B 2-2   General guideline for real loss performance levels[3]

Also calculating the cubic meters per kilometre, which would be a more relevant performance indicator given the low estimated connection density which amounts to approximately 6 cubic meters per kilometre per day for BWE when the system is pressurised, which is low.

[3] *Source: Liemberger, R. and R. Mckenzie. "Accuracy Limitations of the ILI - Is it an Appropriate Indicator for Developing Countries?" (2005).*

Table B 2-5 Evaluation of network size

based on provided information showing implausible results.

Quantity	Unit	BWE
Length of mains (est.)*	km	5,000
Units	No.	220,000
Units density	No./km	44
Subscribers	No.	87,877
Subscriber density	No./km	18

**As extracted from GIS*

Table B 2-6 Estimating an approximate network size

in plausible relation to estimated number of units.

Quantity	Unit	BWE
Units	No.	220,000*
Units per connection	No./No.	4.0
Connections	No.	55,000
Connection density	No./km	11

**for the Bekaa territory*

Table B 2-7 Estimating the number of service connections.

Quantity	Unit	BWE
Units	No.	220,000
Units per connection	No./No.	4.0
Connections	No.	55,000
Connection density	No./km	11

Table B 2-8 Estimating the unavoidable real losses.

Quantity	Unit	BWE
Avg. Pressure	No.	30
Length of mains	km	5,000
Connections	No.	55,000
UARL	m^3/day	4,020
UARL	m^3/year	1,467,300

Table B 2-9 Estimating the real losses for an ILI of 8 for all WEs.

Quantity	Unit	BWE*
UARL	m³/year	1,467,300
Supply continuity	Hour	10
ILI	N/A	8
Real losses (test)	m³	4,891,000
Real losses	l/c/day	244
Real losses (w.s.p)	l/c/day	585
Real losses	m³/km/day	2.7
Real losses (w.s.p)	m³/km/day	6.4

** Including water systems operated by others (municipalities and committees)*

Attempting to calculate the accuracy limits for the above estimates would result in a very high range and therefore these figures provide a guidance towards further investigation.

Proceeding to estimate the unauthorized consumption, and based on this result for real losses, we proceed by estimating the average consumption for all units, then subtracting the consumption for the legal customers. Given the low real metering rates the apparent losses from meter under-registration and data acquisition errors were considered negligible.

Table B 2-10 Estimating the apparent losses for an ILI of 8 for BWE.

Quantity	Unit	BWE
System input volume	m³	53,670,099
Real losses	m³	4,891,000
Consumption	m³	48,779,099
Consumption	m³/day	133,641
Consumption per unit	m³/day	0.61
Authorized consumption	m³	19,484,368
Unauthorized consumption	m³	29,294,731
Water loss	m³	34,185,731

The results were found very sensitive to the number of connections, which are estimated to be within a plausible range of ±30%. In any case, this analysis cannot reach a better conclusion with the current data. To be able to proceed further with more accurate bottom-up analysis based on the knowledge of network size and operation the following is needed:

- Study of connection density based on customer building information.
- Field survey of different networks for evaluating the average operating pressure.
- Development of distribution reports showing number of hours supplied to each network.
- Desktop and field evaluation of the extent of network GIS completion especially at the distribution network level.

B. 2.3 Performance Indicators

As presented, the selected performance indicators for the area of water loss have been calculated. Revisiting the confidence limits, and to illustrate the lack of accuracy, the following are the calculations for the uncertainty for the NRW values that are based on the fewest estimations for BWE.

Table B 2-11 Estimation uncertainty for the NRW variables.

Variables	Unit	Value	± % Error	Reliability	Est. Err.	Std. Err.	Variance
System input volume	m^3	53,670,099	20%	Low	1.E+07	5.E+06	3.E+13
Billed authorized consumption	m^3	38,490,126	2%	High	8.E+05	4.E+05	2.E+11
Non-Revenue Water	m^3	15,179,973	**71%**	Low	1.E+07	5.E+06	3.E+13

And calculating the uncertainty for the percentage the errors are generally high.

Table B 2-12 Estimation uncertainty for the NRW performance indicator.

Performance indicator	Unit	Value	± % Error
Non-Revenue water	%	28%	74%

Therefore, when assessing accuracy bands, and given the issues with data accuracy and reliability, the safe approach is to assume the lowest band for both accuracy and reliability until systematic auditing is implemented.

Table B 2-13 Water loss performance indicators with applicable benchmarks.

Quantity	Unit	BWE	Benchmark	Accuracy	Reliability
Non-Revenue water	%	28%	N/A	42% - 105%	Low
Water loss	%	64%	N/A	27% - 64%	Low
Water losses per connection	l/c/day	1,703	N/A	47% - 67%	Low
Water losses per mains length	m^3/km/day	19	N/A	32% - 57%	Low
Apparent loss index (ALI)	N/A	15	1.0	23% - 69%	Low
Real loss per connection (w.s.p)	l/c/day	**585**	N/A	80% - 86%	Low
Real loss per mains length (w.s.p)	m^3/km/day	6.4	N/A	73% - 79%	Low
ILI (assumes)	N/A	8	2.0	50%	Low

In detail, the assessment of accuracy was conducted for BWE as the following tables illustrate.

Table B 2-14 BWE Water loss analysis with accuracy calculation.

Variables	Unit	Value	± % Error	Value min	Value max	Reliability	Est. Err.	Std. Err.	Variance
Length of mains	km	5,000	20%	4,000	6,000	Mid	1.E+03	5.E+02	3.E+05
Units	No.	220,000	10%	198,000	242,000	Low	2.E+04	1.E+04	1.E+08
Units per connection	No./No.	4	33%	3	5	Low	1.E+00	7.E-01	5.E-01
Connections	No.	55,000	40%	33,076	76,924	Low	2.E+04	1.E+04	1.E+08
Avg. Pressure	No.	30	33%	20	40	Low	1.E+01	5.E+00	3.E+01
UARL	m³/day	4,020	55%	1,790	6,250	Low	2.E+03	1.E+03	1.E+06
ILI (assumed)	N/A	8	50%	4	12	Low	4.E+00	2.E+00	4.E+00
Supply continuity	Hour	10	10%	9	11	Low	1.E+00	5.E-01	3.E-01
Real losses	m³/day	13,400	75%	3,303	23,497	Low	1.E+04	5.E+03	3.E+07
System input volume	m³/day	147,041	9%	133,808	160,275	Low	1.E+04	7.E+03	5.E+07
Consumption (SIV-RL)	m³/day	133,641	12%	116,995	150,287	Low	2.E+04	8.E+03	7.E+07
Unit consumption	m³/day	0.61	16%	0.51	0.70	Low	1.E-01	5.E-02	2.E-03
Subscribers	No.	87,877	1%	86,998	88,756	High	9.E+02	4.E+02	2.E+05
Legal consumption	m³/day	53,382	16%	44,838	61,925	Low	9.E+03	4.E+03	2.E+07
Illegal consumption	m³/day	80,260	23%	61,549	98,970	Low	2.E+04	1.E+04	9.E+07
Water loss (RL+AL)	m³/day	93,660	23%	72,399	114,921	Low	2.E+04	1.E+04	1.E+08
Water loss	%	64%	24%	48%	79%	Low	2.E-01	8.E-02	6.E-03
Water losses per connection	l/c/day	1,703	47%	907	2,499	Low	8.E+02	4.E+02	2.E+05
Water losses per mains length	m³/km/day	19	32%	13	25	Low	6.E+00	3.E+00	9.E+00
Billed authorized consumption	m³/day	105,452	2%	103,343	107,561	High	2.E+03	1.E+03	1.E+06
Apparent loss index (ALI)	N/A	15	23%	12	19	Low	4.E+00	2.E+00	3.E+00
Real loss per connection (w.s.p)	l/c/day	585	86%	83	1,087	Low	5.E+02	3.E+02	7.E+04
Real loss per mains length (w.s.p)	m³/km/day	6	79%	1	11	Low	5.E+00	3.E+00	7.E+00

B. 2.4 Diagnosis of challenges

To assess the factors leading to low performance in water loss management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers PESTEL external factors.

Strengths

- Pilot projects have been introduced in BWE to reduce physical losses using good water distribution practices.

Weaknesses

- No clear roles for water loss assessment, planning, and reduction at the WE.
- WE distribution personnel perform water distribution independently from the best interest of the WE.
- Distribution network information is largely missing from GIS in many areas.

Opportunities

- Interest in NRW project funding.

Threats

- No supervisory or regulatory accountancy by the Ministry on the WE to reduce NRW.
- With the currency crises the financial feasibility of reducing NRW is diminished.
- Social resistance against legal subscriptions especially without fair metering.
- Social resistance against customer metering by high volume consumers.
- No centralised and consolidated data for parcels, buildings, and units to aid in illegal use management and no recent aerial images.
- Mountainous topography and large differences in elevations complicate and increase the cost of good water distribution design practices.

B. 2.5 Recommended actions

The goal was to find better estimates of water loss variables by conducting the exercise done above at the level of water systems, regional departments, as well as the entire WE. That would have allowed us to consider a set of water systems or regions as having more accurate data than others, and therefore help make better estimates at the wider level. However, as presented, much of the data needed is not found even at the level of the water establishment.

Therefore, in summary, it is recommended to :

B. 2.5.1 Pilot area

Identify, in close coordination with the WE, one pilot area to convert into DMA and carry out within this area detailed studies for:

- Detailed customer census in order to assess the consumption needs and its geographic distribution.
- Detailed distribution network survey followed by a hydraulic modelling exercise.
- Installation of bulk flow meters on strategic locations, and water meters on a number of house connections (if not all).
- Assessing the water losses.

B. 2.5.2 Non-Revenue water studies

The lack of data coupled with absence of DMAs impacted the accuracy and quality of the NRW results. Given this finding, the following actions are recommended:

- Implement low cost high impact intervention, the so-called “quick wins” typically the commercial/apparent loss reduction measures instead of the more capital-intensive reduction measures targeting the physical/real loss. The activities consist of customer database update through door-to-door surveys to identify illegal practices, leaks on the service connections, and improved meter management, …
- Implement DMAs for demonstration and trial purposes. The DMAs are used as a diagnostic tool in quantifying physical losses (through bottom-up assessment), and to validate the results of the NRW assessment (top-down assessment).
- Prepare a NRW Reduction Strategy/Plan based on pilot projects outcome and set the NRW targets with the required budget.
- Promote the NRW problem ownership and introduce organizational measures such as working groups, NRW units to boost the implementation capacity.

B. 2.5.3 Shifting to metred consumption policy

Metered consumption is key for reducing NRW, Opex, and overall water consumption. Currently installed water meters across the Beqaa are not read, and are billed at flat rate.

However, based on lessons learned from past experiences, it appears that this is not a top priority and a number of prerequisites are to be implemented before systematically installing water meters, out of which:

- Setting up a team to operate and manage meters’ maintenance and reading.
- Selecting the most adequate meter type based on the adopted reading policy.

- Securing continuous supply in the areas where the meters shall be installed, in order to encourage the consumers to subscribe and accept the idea of water metering.

Water metering projects may be systematically implemented over the whole jurisdiction once the above is implemented and running smooth.

B. 3 ENERGY

While energy cost data was possible to collect, energy use in energy units was more complicated. BWE provided energy use from the grid based on real readings and estimates, yet for 2019 only, and with no clarity over the completion of data and whether it pertains to all or part of the resources and pumping stations.

Table B 3-1 Estimation of the energy use

to calculate the energy use performance indicator.

Variable	Unit	BWE
Energy consumed from grid	kWh	46,247,632
Energy generated from fuel	kWh	
Renewable energy generation	kWh	
Energy recovery	kWh	

The calculated unit energy consumption for BWE does not therefore include all energy costs but only grid energy and for undertermined scope of facilities.

Table B 3-2 Energy use performance indicator.

Performance indicator	Unit	BWE	Benchmark
Unit energy consumption	kWh/m³	0.86	Lower is better
Energy consumed from grid	%		Comparative
Energy generated from fuel	%		Lower is better
Renewable energy generation	%		Higher is better
Energy recovery	%		Higher is better

The energy performance is a complex issue that became more complex with the increasing fuel shortages. BWE has adapted their pumping schedules to align best with grid energy availability, and therefore the extent of the problem would not be realized by calculating the use of each energy source.

An increase in energy availability could on one hand lead to:

- Increased service delivery and longer supply hours.
- Decreased water quality issues due to less cross-contamination during network emptying.
- Decreased need for network resizing in terms of pipe diameters and storage volumes.
- Simpler water distribution and less dependence on local water distribution operators.
- Decreased expenditure on fuel and generators.

- Decreased station and network repairs due to decreased water hammering and vacuum conditions.

But on the other hand, and at least in during the transition could lead to:

- Increased energy costs due to longer working hours.
- Increased water consumption and therefore greater apparent losses.
- Increased real losses due to improved supply continuity.

Therefore, the general impact would be positive if measures were taken to control water losses and improve energy efficiency through better design and regulation of pumping.

To assess the factors leading to low performance on in energy use and management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths • Pilot projects for energy generation have been implemented, and projects for energy recovery have been discussed.
Weaknesses • No records of energy use at WE requiring EDL to share this data. • No assessment of energy use using local fuel generators. • Most pumping lines lack a study for energy reduction potential. • Incomplete knowledge of the system and the relationship between pumping locations and the quantities supplied.
Opportunities • Interest in energy efficiency project funding.
Threats • No supervisory or regulatory accountancy by the Ministry on the WEs to improve energy use efficiency. • With unpaid EDL invoices the financial feasibility of reducing energy use is diminished. • Mountainous topography and political water availability increases the difficulty of reducing energy use.

Due to the limitations in data availability, technical analysis of energy use becomes guesswork. While the records for the cost of energy for both grid energy and fuel are available finacially, there were no estimates for fuel consumption in terms of energy units.

Therefore, the needed improvements include:

- Identification and continuous update of water supply systems as they exist in their actual current form.
- General asset survey and identification of billed grid locations and functions.
- Field study of generator energy use using samples of different sizes of generators.
- Developing a procedure for documenting fuel use and operating hours of generators.

These actions can be integrated with efforts taken in the areas of water loss and water systems.

B. 4 WATER SYSTEMS

The assessment of water systems will no doubt be compromised by the quality of data available. The data provided from the WE generally showed:

- Lack of completeness and comprehensiveness.
- Lack of completeness or regular update regarding the status of assets whether they are planned, under construction, awaiting hand-over, in use, or out of service.
- Lack of completeness regarding asset ownership, who it is operated by, and which water system it serves.
- Lack of a primary central data system for producing asset information and the reliance on various sources and personal knowledge.
- No standard asset types or asset hierarchy, even if work has been done for creating these standards.

B. 4.1 Water resources

The assessment of water resources looks at production, treatment, and reuse. The indicators look at the WE level due to the lack of more granular data given that:

- Surplus in water production capacity at the WE level does not mean sufficiency of water resources at the local level.
- The topography of current water systems is not documented. The NWSS proposed and defined water systems as a strategic water security measure but the actual situation does not correspond to that proposal.
- Resources of the regional departments at the WE may geographically be located in one region but supplying other regions. Until the water systems are documented and the quantities crossing from one region to another are estimated regional assessment cannot be concluded.

Table B 4-1 Water production and treatment assets.

Variable	Unit	BWE
Number of water supply systems	No.	
Wells	No.	291*
Springs	No.	68*
Dams	No.	-
Pumping stations	No.	38

- *As extracted from GIS covers all facilities operated by BWE and others.*

Moreover, when examining the production capacity, the following assumptions have to be made:

- Maximum operating hours, and whether the capacity reported is artificially reduced due to the shortage of electricity.
- The current safe yield and whether the capacity reported pertains to theoretical or outdated levels.

With these limitations in mind and proceeding to look at the available data, the estimates given or calculated for water production capacity for the WE are as follows:

Table B 4-2 Water resource variables.

Variable	Unit	BWE
Wells daily production capacity	m³/day	
Springs daily production capacity	m³/day	
Dams daily production capacity	m³/day	
Total daily production capacity	m³/day	
Daily treatment capacity	m³/day	
Maximum water treated daily	m³/day	
System input volume	m³/day	186,301

The treatment capacity assuming all produced water will be as follows:

Table B 4-3 Water resource performance indicators.

Performance indicator	Unit	BWE
Water production capacity utilization	%	
Treatment plant capacity utilization	%	
Reuse supplied water	%	0%

Calculating capacity utilization, it can be seen that while on average production is limited by demand satisfaction during the winter season in some locations, it is also limited by grid power availability and the economy of local energy production.

For the WE to be able to accurately assess supply sufficiency, the following studies are needed:

- Technical assessment of current sources safe yields and maximum working hours.
- Assessment of source water quality and the sufficiency of the current level of water treatment.
- Mapping of supply topography and definition and update of supply systems.
- Evaluation of the current and future demand for distribution zones.

B. 4.2 Storage

Storage capacity at the level of the WE may not reflect local water storage sufficiency but provides a quick insight in some cases.

Table B 4-4 Water storage variables.

Variable	Unit	BWE
Raw water storage capacity	m^3	
Number of transmission and distribution storage tanks	No.	320
Treated water storage capacity	m^3	166,252

Table B 4-5 Water storage performance indicators.

Performance indicator	Unit	BWE
Raw water storage capacity	days	
Transmission and distribution storage capacity	days	0.89

For the WE to be able to accurately assess storage capacity, the following studies are needed:

- Completion and auditing of reservoir storage capacity information.
- Mapping of storage topography and definition and update of supply systems as well as distribution zones supplied by each reservoir.
- Evaluation of the current and future demand for distribution zones.

B. 4.3 Metering

B. 4.3.1 Present situation

Presently (2020) there is 32,401 domestic water meters installed in various areas of the jurisdiction of BWE. The rate of metered subscriptions is 36%.

However, the meters are not read and billing is made as gauged subscriptions

B. 4.3.1 Metering needs

To estimate the size of bulk metering needed, we look first at the production and transmission bulk metering that applies to sources, reservoirs, and pump station. The number would not match exactly the actual need of bulk meters but could provide a minimum benchmark that one bulk meter is installed in every location at minimum. To calculate the number of plants, we add the number of sources and reservoirs given above to the estimated number of pump stations.

Table B 4-6 Pumping stations and pumps.

Variable	Unit	BWE
Pumping stations	No.	38
Pumps	No.	

Therefore, we have the bases for the performance indicators as follows:

Table B 4-7 Metering base variables in year 2019

Variable	Unit	BWE
Total plants (sources, PSs, TPs, Reservoirs)	No.	
Connections	No.	55,000
Subscribers	No.	87,979

The actual performance in metering for each kind is estimated form the data gathered where possible as follows:

Table B 4-8 Metering performance variables.

Variable	Unit	BWE
Production and transmission meters	No.	
District meters	No.	
Subscriber meters	No.	33,114

Therefore, the metering performance can be calculated in BWE.

Table B 4-9 Metering performance indicators.

Performance indicator	Unit	BWE	Benchmark
Production and transmission meter density	No./plant		100%
District meter density	No./1000 connections		100%
Customer metering	%	38%	100%

Metering is essential for measuring some of the most vital water establishment metrics relative to NRW and energy use. Given that the target / benchmark is to reach 100% or complete metering of all sources, plants, districts, and customers, the implementation could be gradual and slow. To be able to better conceive stategies, invest in, track, and evaluate the performance in metering, the following are needed:

- Survey of water production, treatment, storage, and pumping facilities and transmission systems and evaluation of bulk metering needs.
- Bulk meter survey and calibration to determine conditions and maintenance needs.
- Survey of customer meters and evaluation of their condition as to re-evaluate the current level of performance based on active and functional meters.
- Development of meter management modules and procedures.
- Investigation of private sector opportunities for the specialised maintenance of advanced metering equipment.

B. 4.4 SCADA

The evaluation aims at evaluating the level of automation and remote monitoring and control of water facilities. SCADA system has been implemented in BWE where a number of facilities of concern have been chosen as a proxy for the number of control units, and the level of automation and remote control has been given as follows:

Table B 4-10 SCADA variables.

Variable	Unit	BWE
Control units	No.	
Automated facilities	No.	35
Remotely controlled units	No.	

That allows the calculation of the level of performance in implementing SCADA system as follows:

Table B 4-11 SCADA performance indicators.

Performance indicator	Unit	BWE
Facility automation degree	%	34
Facility remote control degree	%	

Ideally, control units should be used to represent points on the production and transition system such as pump control panels, reservoir inlet and outlet valves, and other critical system valves. To improve the analysis and management of the automation efforts the following are needed:

- Survey of facilities to define control units of interest.
- Evaluation of each control unit's criticality within the framework of safety planning and crises mitigation as well as instrumentation and metering needs.
- Investigation of private sector opportunities for the specialized maintenance of SCADA systems.

B. 4.5 Diagnosis of challenges

To assess the factors leading to low performance in water system management, including difficulties in producing the needed data, we attempt to portray the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths • Focus on water resource sufficiency and storage capacity expansion across the WE. • SCADA and automation have been initiated in BWE and should be implemented.
Weaknesses • The level of water treatment cannot be assured especially at small remote sources. • WE does not have the capacity to manage large numbers of bulk and household water meters. • Information about facilities is rarely updated, highly unreliable, and incomplete on GIS. • Distribution networks layouts are largely missing. • Small water resources are unmetered, or meters are dysfunctional.
Opportunities • Funding opportunities focus on water resources, storage, and associated measurement and control technologies. • Investment in household metering is interesting to funding agencies.
Threats • Many small production and transmission facilities increase the complexity of asset management and the cost of SCADA. • Vulnerability of field equipment and accessories

B. 4.6 Recommended actions

In summary, and with many common actions recommended across technical areas, the following recommendations can be made for the Development of a systematic facility and asset status update mechanism to eliminate the constant need for repeating surveys. This includes the following:

B. 4.6.1 Master plan / Strategy

BWE master plan needs to be updated, including a cost benefit analysis for capital investment projects needed in the short term, considering the impact of the new developments on the status of the WE's human resources and the ability to implement the set targets. Possible blockages in projects' implementation due to self-proclaimed water rights is a serious issue that needs to be taken into consideration when drafting any Master Plan

Estimated duration: 24 Months

B. 4.6.2 Digitalization

The various data, whether financial or technical should be centralized in one data centre or digital platform, therefore it is necessary to:

- Carry out an assessment of all data acquisition/processing systems in use at the WE and design a new data centre, to be implemented by steps, in the view of a central digitalization system for the whole WE. Based on the outcome of this assessment, the below steps would be carried out, in all or partially.
- Carry out studies for the improvement/replacement - if deemed necessary - of the existing ERP system, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the improvement and eventual extension of the existing GIS system to cover the acquisition of all technical data, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the design of a data acquisition and processing system to cover the monitoring and management of the production and distribution flows; with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building. Supply and installation of the required remote sensors for the operation of the systems shall not be part of these Tender Documents.
- Implementation of the digitalization system.

B. 4.6.3 Water production – Available water resources

Presently, the water production is not adequately monitored as the current SCADA system does not cover all the facilities, and does not produce comprehensive reports; the production figures provided by BWE are based on operators' *best estimate*.

Therefore, it is necessary to:

- Carry out a general survey of all water sources presently in service; assess the status of the existing flow measurement equipment if any;
- Prepare Tender Documents for the implementation of flow/yield measurement equipment on all water sources, linked to the central production data centre.
  Because the cost for installing measurement equipment on all the water sources presently in service is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

B. 4.6.4 Water distribution

Here again, the distributed flow provided by the WE is an operator's *best estimate*, due to the lack of flow measurement at the level of the distribution centres or reservoirs.

Therefore, it is necessary to:

- Carry out a general survey of all distribution zones and identify the feeding point(s) of each, and assess the status of the existing flow measurement equipment at each feeding point, if any
- Prepare Tender Documents for the implementation of flow/consumption measurement equipment on each supply point of each distribution zone, linked to the central production data centre.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.
- Identify existing DMAs and/or areas that could possibly be turned into DMAs, and identify possible locations for the installation of bulk flow/consumption meters on the distribution network, linked to the central production data centre; and prepare Tender Documents for the supply and installation of such equipment.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

B. 4.6.5 Production cost optimization

With the present financial situation, energy has become the major component of production cost, nearing 56 %. BWE's strategy is to implement renewable energy sources such as hydroelectric or solar, in addition to shifting from underground to surface water sources, where possible. However, there is no comprehensive view of the subject.

Therefore, it is necessary to carry out a general *Cost Optimisation Master Plan* covering in details all the available options over the WE's jurisdiction, and setting up the upper threshold of what could be possibly achieved in this field.

B. 4.6.6 Taking over the wastewater sector

BWE is unable to bear the cost of operating its waste water treatment plants, so financing must be provided from other sources (GoL or donors) to:

- Outsource the operation and maintenance of each treatment plant and related network to private operators via performance-based contracts.
- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts.

B. 5 OPERATION AND MAINTENANCE

One of the areas suffering from the most data shortage is operation and maintenance. While asset information can be recovered to an extent in the future, the records of today's work will be lost if not documented within a short space of time. Moreover, the practice to record daily work is often adequate when the management is trying to constantly diagnose the problems, find weak areas, and strive to improve performance in with a long-term vision and a continuous strive for achieving success. On the other hand, when the establishment is weakened by various external and internal factors, the management process may get broken and simple requests such as filling out a work order may become impossible to fulfil.

B. 5.1 Inspection and calibration

As expected, no records were available on inspection and calibration activities. BWE is in the process of receiving an EU funded mobile system.

The suggested benchmark is a preliminary one and will require specialized input in both asset type-related and facility-related considerations. Values remain unknown.

Table B 5-1 Inspection and calibration performance indicators.

Performance indicator	Unit	BWE	Benchmark
Pump inspection	%		100%
System valve inspection	%		100%
Control valve inspection	%		100%
Reservoir cleaning	%		100%
Network inspection	%		100%
Service connection inspection	%		100%
Instrument and inspection and calibration	%		100%
System flow meters calibration	%		100%
Pressure meters calibration	%		100%
Water level meters calibration	%		100%
Water quality sensor calibration	%		100%
Control unit inspection and calibration	%		100%
Electrical panel inspection	%		100%

The importance of preventive and predictive inspection of system assets as well as the calibration of instruments are vital for avoiding the collapse of service quality and sustaining resilience. Moreover, the ability of the public sector to maintain quality control over an operational contract is empowered by requesting and auditing daily inspection activities instead of waiting until a failure occurs -often due to the lack of inspection and preventive maintenance.

Currently, these processes may not be performed regularly and sufficiently, however, every establishment performs a varying level inspection activity through its operators and technicians at the production plants and pumping stations and sometimes daily. To be able to monitor and improve the performance in this area, the following is needed:

- Assessment of preventative maintenance needs and schedules for each asset type and specifically for each facility.
- Establishing procedures for updating the preventative maintenance plan when needed.
- Investigation of private-sector opportunities for providing specialized regular scheduled inspections and calibrations when the WE cannot.
- Adoption of standard reporting practices to be applicable with the WE's maintenance system.

B. 5.2 Rehabilitation and replacement

Rehabilitation and replacement in general, including corrective maintenance produced during rehabilitation efforts, are often the last resort for a failing segment of the system. Therefore, an exceedingly high level of rehabilitation and replacement is not ideal. They are still a necessary fact that some parts of the system will need rehabilitation and therefore a WE should demonstrate investment in that area.

Due to often requiring external contracts, data exists, if not by any means reliably comprehensive.

Table B 5-2 Rehabilitation and replacement variables.

Variable	Unit	BWE
Mains rehabilitation and replacement	km	
Service connection rehabilitation and replacement	No.	
System valve rehabilitation and replacement	No.	
Control valve rehabilitation and replacement	No.	
Pump rehabilitation and replacement	No.	
System flowmeter rehabilitation and replacement	No.	
Customer flowmeter rehabilitation and replacement	No.	
Leaks repaired	No.	

More precise information is needed which can be achieved by regular and systematic work documentation in digital format.

Table B 5-3 Rehabilitation and replacement performance indicators.

Performance indicator	Unit	BWE
Mains rehabilitation and replacement	%	
Service connection rehabilitation and replacement	%	
System valve rehabilitation and replacement	%	
Control valve rehabilitation and replacement	%	
Pump rehabilitation and replacement	%	
System flowmeter rehabilitation and replacement	%	
Customer flowmeter rehabilitation and replacement	%	
Leaks repaired	No./100 km	

Values about rehabilitation and replacement were not made available for the TA. We should note that rehabilitation and maintenanace are not excuted in a schedule manner. The most of rehabilitation works are corresponding to corrective interventions. We didn't find any tool or document for the planification of rehabilitation and maintenance works. It is of great intrest that the WE starts to introduce the concept of planned rehabilitation programs covering all tye of works as corrective, planned and preventive rehabilitation.

B. 5.3 Vehicles

Vehicle availability is vital for establishing field presence and traversing the service areas to operate and maintain assets.

Table B 5-4 Vehicle availability variables.

Variable	Unit	BWE
Operating vehicles	No.	48
Length of mains	km	5,000
Subscribers	No.	87,877

Table B 5-5 Vehicle availability performance indicators.

Performance indicator	Unit	BWE
Vehicle availability	No./100	0.5

B. 5.4 Customer metering

Asides from owning the needed customer meter assets, the use of customer meters for calculating quantities and billing amounts are needed. Billing is issued yearly and customer meters are billed as gauge subscriptions.

Table B 5-6 Customer metering variables.

Variable	Unit	BWE
Customer meter read	No.	
Customers billed based on metering	No.	
Customer meters	No.	33,114

Billing proceeds yearly and customer meters are billed as gauge subscriptions.

Table B 5-7 Customer metering performance indicators.

Performance indicator	Unit	BWE
Customer meter reading efficiency	%	Low
Customers billed based on metering	%	Non

B. 5.5 Water quality testing

The table shows the number of water quality tests carried out in BWE.

Table B 5-8 Water quality testing variables.

Variable	Unit	BWE
Required treated water quality tests	No.	
Required aesthetic tests	No.	
Required microbiological tests	No.	
Required physical-chemical tests	No.	
Required radioactivity tests	No.	
Required water quality tests carried out	No.	3,993
Aesthetic tests carried out	No.	65
Microbiological tests carried out	No.	2,108
Physical-chemical tests carried out	No.	1,820
Radioactivity tests carried out	No.	

Table B 5-9 Water quality testing performance indicators.

Performance indicator	Unit	BWE
Aesthetic tests carried out	%	2
Microbiological tests carried out	%	52
Physical-chemical tests carried out	%	46
Radioactivity tests carried out	%	

B. 5.6 Diagnosis of challenges

To assess the factors leading to low performance in operation and maintenance, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths

- Existing CMMS (Computer Maintenance Management System) system at BWE (Baalbeck section).

Weaknesses

- Lacking manpower and qualifications required to set up, update, and operate the system.
- Requests and work orders affecting financial decisions such as material requests are required to be paper based and manually signed, limiting the application of maintenance systems.
- Difficulty in narrowing down the assets requiring preventive maintenance, inspection, or calibration and the required maintenance for each.
- Difficulty in assessing the sampling and quality testing of sources and networks according to the Lebanese standards.
- Maintenance information is often lacking, and when available focus to major contracted works at facilities.
- No records of network failures that may aid in assessing the condition of network assets.
- WE has no capacity to perform acceptable levels of regular maintenance.

Opportunities

- Technology is available that enables the implementation of comprehensive management and control over operations and maintenances with minor overhead.

Threats

- Reliance on external contractors weakens the ability to closely monitor and manage maintenance activities.

B. 5.7 Recommended actions

Similar to previously mentioned points in the area of systems, with the additional focus on water quality and meter management systems and systematic update. Primarily, a work order system that works across the office and the field and based on GIS is key for planning, implementing, and evaluating operation and maintenance practices and related costs. Specifically:

- Study of the scheduled maintenance needs for each asset type and development of a maintenance program. This will also help identify the needs of staffing and vehicles for the WE.
- Completion of and standardisation of maintenance forms for BWE, review of existing systems, and planning revisions and development of capable maintenance management system upgrade and the integration with mobile applications for field functions.
- Study of and update of the water sampling and testing needs for BWE. This will also help identify the needs of staffing and vehicles for BWE.
- Review of existing water quality systems, reporting capability, regulatory compliance, and planning revisions and development of capable water quality system upgrade and the integration with mobile applications for field functions.
- Study of the cost and benefit of customer metering for both simple flow meters and smart static meters with remote reading capabilities. This will also help identify the needs of staffing and vehicles for BWE.
- Development and enforcement of a criteria for inspecting and assessing the quality of water mains and service connections and the development of a replacement strategy that minimizes pipe replacement before all attempts at maintenance have been taken, and where replacement proves to be a more cost-effective solution.

In order to enhance efficiency and reduce the cost of O&M, it is necessary to design a modern preventive/corrective maintenance system, and implement it in the view of central digitalization system for the whole WE.

B. 6 QUALITY OF SERVICE

B. 6.1 Service coverage

Supply coverage is a key performance indicator. Determining the coverage ratio in cases where 100% cannot be assumed requires information about the total number of units. In the case of Lebanon, the total number of units is more often estimated using utility data, so we chose rough estimates of the number of units for the purpose of this assessment.

A better estimation can be made by assuming that the number of units served by the WE is equal to the total number of subscriptions. More data was provided by BWE from 2019 when it reported an approximately 23491 units being supplied by municipalities and committees.

Table B 6-1 Service coverage variables in 2019.

Variable	Unit	BWE
Units*	No.	220,000
Subscribers	No.	87,979
Unit supplied legally by WE	No.	87,979
Unit supplied by other entities	No.	24,000
Unit supplied by illegal connections	No.	

Including the 23 491 units supplied by municipalities and committees

It therefore remains that service coverage cannot be determined, especially since the expected coverage by all entities and means is expected to be close to 100%. The ratio of illegally connected units can still be estimated, if with a large margin of uncertainty coming from estimating the total number of units.

Table B 6-2 Service coverage performance indicators.

Performance indicator	Unit	BWE
Service coverage	%	
Unit supply coverage legally by WE	%	40%
Unit supply coverage by other entities	%	11%
Unit supply coverage by illegal connections	%	60%

B. 6.2 Supply continuity

Supply continuity is a key performance indicator. Continuity often means good level of service, more satisfied customers, fewer water quality risks, and longer asset life. The performance is usually affected by bad maintenance and shortage in water resources. In the case of Lebanon, continuity is primarily affected by power availability, therefore also storage capacity. Local power generation is possible, and some sources can be operated for extended periods, yet it is not feasible for the WE to always generate power in all locations when power supply from the grid is not available.

Given the imposing situation beyond the control of WE, the issue of continuity has often remained in the background. The hours of supply are still not known, and previous estimates focused more on source operating hours not distribution supply hours.

Table B 6-3 Supply continuity variables.

Variable	Unit	BWE
Avg. supply duration	h/day	10
Listed number of networks	No.	
Network with 24 h/day or more	No.	
Estimated customers with continuous supply	%	

The resulting performance can not be therefore calculated for BWE. Given the importance of this key performance indicator, supply continuity was estimated for BWE as 40% as an initial figure, based on an average of approximately 10 hours per day.

Table B 6-4 Supply continuity performance indicators.

Variable	Unit	BWE
Supply continuity	%	~ 40%
Population receiving continuous supply	%	Low

B. 6.3 Water quality compliance

Assessment of water quality compliance requires clear standards and transparent reporting. The number of potable water tests carried out were were estimated for BWE from raw data.

Table B 6-5 Water quality compliance base variables.

Variable	Unit	BWE
Treated water quality tests carried out	No.	3,993
Aesthetic tests carried out	No.	65
Microbiological tests carried out	No.	2,108
Physical-chemical tests carried out	No.	1,820
Radioactivity tests carried out	No.	

We used the raw data provided by BWE to estimate the compliance level for microbiological tests. It should be stated that the compliance percentages should apply to the required samples by regulation. Additional samples are usually taken by water utilities from risky or problematic areas which produces a seemingly lower compliance, as can be seen in the case of BWE.

Table B 6-6 Water quality compliance performance variables.

Variable	Unit	BWE
Quality of supplied water	No.	
Aesthetic tests compliance	No.	
Microbiological tests compliance	No.	1,730
Physical-chemical tests compliance	No.	
Radioactivity tests compliance	No.	

The resulting compliance levels therefore cannot be taken without the review of the standards and requirements for sampling and testing, covered under the technical part.

Table B 6-7 Water quality compliance performance indicators.

Performance indicator	Unit	BWE	Benchmark
Quality of supplied water	%		100%
Aesthetic tests compliance	%		100%
Microbiological tests compliance	%	82%	100%
Physical-chemical tests compliance	%		100%
Radioactivity tests compliance	%		100%

B. 6.4 Response speed

Improving customer service depends on improving the speed of performing the services, especially in the case of Lebanese WE, where encouraging users to legally subscribe and install a meter can be hampered by long waiting time, especially for new users.

Unfortunately, the speed of service data could not be collected, and to our best knowledge is in some cases difficult to consolidate from the systems and paperwork, and in other cases impossible.

Table B 6-8 Response speed performance indicators.

Performance indicator	Unit	BWE	Benchmark
Average response time to customer complaints	Hours		48
New connection establishment time	days		14
Time to install a customer meter/gauge	days		14
Connection repair time	days		1

The suggested benchmark is indicative and should be revised by the supervisory body or regulator.

Therefore, to improve the measurement -and therefore management- of response speed the following is needed:

- Completion of the digitisation of customer transactions, especially in remote offices and where systems are prone to power failures.

- Design of reports in the customer management systems that capture time of request instigation and time of completion.
- Use of mobile application for distribution departments that include customer service requests and work orders.

B. 6.5 Customer complaints

Reducing the need for customer complaints and the time to respond to customer complaints are essential part of the mission of any water utility. However, in the case of Lebanon, the number of recorded complaints is abnormally low. Moreover, the number of complaints is generally higher in the better served larger cities and towns than remote villages. If anything, the numbers record the extent in which customers interact officially with the WE, as opposed to submitting complaints informally to a WE staff member, not having a legal subscription to allow complaining, or not expecting a response from a WE, especially in the remote areas.

We summarised an estimate of the needed variables from the data provided as follows:

Table B 6-9 Customer complaints variables.

Variable	Unit	BWE
Billing complaints and queries	No.	
Service complaints	No.	320
Pressure complaints	No.	29
Continuity and interruption complaints	No.	228
Water quality complaints	No.	2

And the results show that BWE has high recorded number of complaints compared to other WE. Therefore the customer complaints performance indicators in BWE can be calculated as follows:

Table B 6-10 Customer complaints performance indicators.

Performance indicator	Unit	BWE
Billing complaints and queries	No./1000 customer	
Service complaints per connections	No./1000 customer	3.6
Pressure complaints	No./1000 customer	0.3
Continuity and interruption complaints	No./1000 customer	2.6
Water quality complaints	No./1000 customer	0.0

BWE has initiated one or more systems of documenting complaints over the years, with some of them being integrated with the WE ERP. However, common issues are seen such as:

- Incomplete campaigning for centralising a call centre and a centralised operations command to allow centralised control. Otherwise, local centres operating using the same system and procedures can perform similarly.

- Incomplete internal capacity and internal management of staff to re-route customer requests through the call centre.
- Inconsistent attribution of complaint types.
- No separation between claims and reports of incidents such as leaks and service complaints.
- No method for documenting billing complaints.

Therefore, and to allow for improved receiving and handling of customer complaints the following are needed:

- Standardisation of report types and definitions, including the separation of incident reports and service complaints.
- Development of a standardised customer application to enhance customer communication, to be managed by each WE independently.

B. 6.6 Diagnosis of challenges

To assess the factors leading to low performance on in service quality, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths • Customer care centre website and mobile applications available for customers' communication.
Weaknesses • No sufficient capacity for responding to all customer complaints. • Large volumes of customer complaints remain to be processed outside of official channels.
Opportunities • Mobile applications provide a technological solution for saving cost and staff needed to achieve wider communication with customers. • Relaunching of WE with awareness campaigns, while maintaining good performance, may help establish trust and cooperation with users.
Threats • Other than in Zahle, water users have not developed the habit of contacting the call centre to report service complaints. • Power shortages hinders the possibility of constant supply.

B. 6.7 Recommended actions

A strong customer service function that looks into both technical and administrative issues related to service delivery is key. Many attempts have been made with the support of donors to improve communications between the BWE and the public: The establishment of Zahle customer care center and the adoption of a CRM application with USAID support , the creation of a centralized customer service with a 4 digit emergency number, putting up a website and social network pages, pamphlet publications, ad campaigns, town hall meetings, the creation of a mobile application to locate and report complaints, as well as many censuses and customer surveys; All have relatively failed to achieve expected results and for multiple reasons, ranging from lacks in initial project inception, flawed execution, inadequate implementation by BWE staff, to poor follow up. Add to that peoples' aversion to cooperate with the WE's be it for legitimate reasons or otherwise.

With the aforementioned improvements needed for identifying system components and managing operations and maintenance, on the customer side, the following is recommended:

- Investment in a standardised if not necessarily centralised customer application that allows for:
  - Complete updating its subscribers' database
  - Ensure necessary staff is available, trained, and motivated
  - 24/7 reporting of complaints and observations such as leakage or water theft.
  - Live tracking of the status of their reports.
  - Immediate update of scheduled or unscheduled water interruptions, source quality issues, and any general announcements.
  - Calculation of complaint types, average response times, size of backlog.
- Promotion of the call centres or call desks into 23/7 complaint and command/control centres. Available SCADA as well as minor investments in remote monitoring of pressure and flow can assist the centre perform more informed decisions.
- Targeted promotion of legal subscription in areas where improved WE capacity, asset conditions, and resource sufficiency can be ensured.
- Phone and web surveys of statistically representative random sample of users to assess concerns and reporting of anonymous subscription statuses across all regions.
- Study for evaluating of the size and capacity of fields units needed in each regional department for performing satisfactory complaint handling to achieve improved service delivery.

APPENDICES

APPENDIX 1. Selection of performanc indicators

The IWA's performance Indicators for water supply services offer a rich selection of performance indicators that capture different areas of interest for monitoring the performance of water establishments. However, for the case of Lebanon, not all these indicators are relevant, pressing, or even sufficient.

Several issues of special interest to Lebanon include:

- The personnel assessment assumed for most water utilities depends on the permanently employed personnel. While there are often other sources for the work force such as daily labor or operating contracts, they are usually small and of less interest than official employees. In the case of Lebanese WEs, and due to difficulty of securing government approvals for the hiring of new employees, most of the working staff has been composed of contracted people with no official employment status. Monitoring the evolution of the staff profile is therefore of great interest.
- Subscribers represent a fraction of served connections. Using the number of legal subscribers to size the system therefore would negate the strategic goal of improving subscriptions and therefore collections. Also of interest is that even if the service area and responsibilities of WEs are well defined, many municipalities and committees have taken over the role of water and wastewater utility management and provide to their own districts or in mixed districts -a situation that may not continue if the WEs have the needed capacity to take over. The actual size of the service area and the monitoring of illegal use and supply by other entities are of great interest in Lebanon.
- Customer metering has become a normal method of operation in water utilities, yet in Lebanon it remains the exception. That and the high prevalence of illegal connections, the assessment of non-revenue water based on billed amounts becomes much less effective and much more uncertain. Moreover, the information about metered production quantities is almost non-existent even for the few metered bulk sources. Therefore, it is of great interest to estimate the actual legitimate consumption as well as the illegal connections as a first step in water loss evaluation.
- Power supply for pumping is an intricate issue that includes grid power intermittency, bureaucracy in getting approvals for subscriptions, using less cost-efficient local generators that depend on the availability of fossil fuels. The assessment and monitoring of power sources and their effects on supply continuity is therefore of great interest in Lebanon.
- The IWA performance Indicators assume a situation with clearly defined treatment plants and bulk water imports being the main sources of water, while in many parts of the region a large array of water sources includes wells, springs, dams, sizes small and

large, treated by many local chlorination machines or large treatment plants. It is therefore of great interest to monitor the type and quality of different kinds of supply sources.

We will now present the original performance indicators as sourced from the IWA reference and the proposed indicators for use for this assessment. At a later stage, and based on dedicated work for setting up a performance monitoring system, a final set of indicators will be defined. The IWA performance indicators for personnel supply services include a section on personnel, as shown in Table B 1-1 below.

Appendix Table 1 Performance indicators in the area of personnel

Code	Area	Performance indicator	Unit
Pe1	Total personnel	Employees per connection	No./1000 connections
Pe2		Employees per water produced	No./(10^6m^3)
Pe3	Personnel per main function	General management personnel	%
Pe4		Human resources management personnel	%
Pe5		Financial and commercial personnel	%
Pe6		Customer services personnel	%
Pe7		Technical service personnel	%
Pe8		Planning & construction personnel	%
Pe9		Operations & maintenance personnel	%
Pe10	Technical services personnel per activity	Water resources and catchment management personnel	No./(10^6m^3)
Pe11		Water resources and catchment management personnel	No./(10^6m^3)
Pe12		Transmission, storage and distribution personnel	No./100 km
Pe13		Water quality monitoring personnel	No. /1000 tests
Pe14		Meter management personnel	No. /1000 meters
Pe15		Support service personnel	%
Pe16	Personnel qualification	University degree personnel	%
Pe17		Basic education personnel	%
Pe18		Other qualification personnel	%
Pe19	Personnel training	Total training	Hours / employee
Pe20		Internal training	Hours / employee
Pe21		External training	Hours / employee
Pe22	Personnel health and safety	Working accidents	No./100 employees
Pe23		Absenteeism	days / employee
Pe24		Absenteeism due to accidents or illness at work	days / employee
Pe25		Absenteeism due to other reasons	days / employee
Pe26	Overtime	Overtime work	%

We are proposing using more detailed classifications due to the emphasis on comparing personnel business areas from different WEs where departments are less comparable. Also for comparing where the shortage of staff is affecting how the WEs are adhering to the organisational by-laws, detailed job types were used.

Appendix Table 2 Proposed performance indicators in the area of personnel.

Area	Performance indicator	Unit
Total personnel	Employees per connection	No./1000 connections
	Employees per customer	No./1000 customers
	Employees per water produced	No./($10^6 m^3$)
	Permanent employees	%
Personnel per business area	Customer service	No./1000 connections
	Distribution	No./($10^6 m^3$)
	Engineering	%
	Facilities	No./($10^6 m^3$)
	Finance	%
	General	%
	HR	%
	Water quality	%
Personnel per job type	Auxiliary - Clerical	No./($10^6 m^3$)
	Auxiliary - Driver	%
	Auxiliary - Guard	%
	Auxiliary - Office boy	%
	Collector / Reader	No./1000 meters
	Customer service	No./1000 customers
	Financial / Administrative	%
	Management	%
	Management (Eng.)	%
	Technical - Driver	%
	Technical - Engineer	%
	Technical - laborer	%
	Technical - Other	%
	Technical - Water quality	No./1000 samples
Personnel qualification	University degree personnel	%
	Basic education personnel	%
	Other qualification personnel	%
Personnel	Training	Hours / employee
Personnel health and safety	Working accidents	No./100 employees
	Absenteeism	days / employee
	Absenteeism due to accidents or illness at work	days / employee
	Absenteeism due to other reasons	days / employee
Overtime	Overtime work	%

The IWA performance indicators for water supply services also include a section on water resources, physical systems, and operations as shown in Table B 1-3, Table B 1-4 and Table B 1-5.

Appendix Table 3 IWA performance indicators in the area of water resources.

Code	Area	Performance indicator	Unit
WR1	Water resources	Inefficiency of use of water resources	%
WR2		Water resources availability	%
WR3		Own water resources availability	%
WR4		Reuse supplied water	%

Appendix Table 4 IWA performance indicators in the area of physical systems.

Code	Area	Performance indicator	days
Ph1	Treatment	Treatment plant utilization	%
Ph2	Storage	Raw water storage capacity	days
Ph3		Transmission and distribution storage capacity	days
Ph4	Pumping	Pumping utilization	%
Ph5		Standard energy consumption	kWh/m³/100m
Ph6		Reactive energy consumption	%
Ph7		Energy recovery	%
Ph8	Transmission and distribution	Valve density	No./km
Ph9		Hydrant density	No./km
Ph10	Meters	District meter density	No./1000 connections
Ph11		Customer meter density	No./connections
Ph12		Metered customers	No./customer
Ph13		Metered residential customers	No./customer
Ph14	Automation and control	Automation degree	%
Ph15		Remote control degree	%

Appendix Table 5 IWA performance indicators in the area of operation.

Code	Area	Performance indicator	Unit
Op1	Inspection and maintenance of physical assets	Pump inspection	%
Op2		Storage tank cleaning	%
Op3		Network inspection	%
Op4		Leakage control	%
Op5		Active leakage control repairs	No./100 km
Op6		Hydrant inspection	%
Op7	Instrumentation calibration	System flow meters calibration	%
Op8		Meter replacement	%
Op9		Pressure meters calibration	%
Op10		Water level meters calibration	%
Op11		On-line water quality monitoring equipment calibration	%
Op12	Electrical and signal transmission	Emergency power systems inspection	%
Op13		Signal transmission equipment inspection	%
Op14		Electrical switchgear equipment inspection	%
Op15	Vehicles	Vehicle availability	No./100 km
Op16	Mains, valves and service connection rehabilitation	Mains rehabilitation	%
Op17		Mains renovation	%
Op18		Mains replacement	%
Op19		Replaced valves	%
Op20		Service connection rehabilitation	%
Op21	Pump rehabilitation	Pump refurbishment	%
Op22		Pump replacement	%
Op23	Operational water losses	Water losses per connection	m^3/connection
Op24		Water losses per mains length	m^3/km/day
Op25		Apparent losses	%
Op26		Apparent losses per system input volume	%
Op27		Real losses per connection (w.s.p)	l/c/d
Op28		Real losses per mains length (w.s.p)	l/c/d
Op29		Infrastructure leakage index	N/A
Op30	Failure	Pump failures	days/pump
Op31		Mains failures	No.100km
Op32		Service connection failures	No./1000 connections
Op33		Hydrant failures	No./1000 hydrants
Op34		Power failures	hours/pumping stations
Op35		Water point failures	No./water points
Op36	Water metering	Customer reading efficiency	%
Op37		Residential customer reading efficiency	%
Op38		Operational meters	%
Op39		Unmetered water	%
Op40	Water quality monitoring	Test carried out	%
Op41		Aesthetic tests carried out	%
Op42		Microbiological tests carried out	%
Op43		Physical-chemical tests carried out	%
Op44		Radioactivity tests carried out	%

We propose a redesign and emphasis in a similar way but in ways more relevant to the situation in Lebanon. One section combines indicators for water loss as shown in Table B 1-6.

Appendix Table 6 Proposed water loss performance indicators.

Performance indicator	Unit
Non-revenue water	%
Water loss	%
Water losses per connection	l/c/d
Water losses per mains length	m^3/km/day
Apparent loss index (ALI)	N/A
Real loss per connection (w.s.p.))	l/c/d
Real loss per mains length (w.s.p.)	m^3/km/day
Infrastructure leakage index (ILI)	N/A

Where water loss here is used specifically for this context to represent the difference between the estimated system input and authorized consumption, while non-revenue water is used for the difference between the system input and the billed amounts.

One section details energy indicators relevant to the situation of Lebanon as shown in Table B 1-7.

Appendix Table 7 Proposed energy performance indicators.

Performance indicator	Unit
Unit energy consumption	kWh/m^3
Energy consumed from grid	%
Energy generated from fuel	%
Renewable energy generation	%
Energy recovery	%

One section details system indicators relevant for Lebanon as shown in Table B 1-8.

Appendix Table 8 Proposed performance indicators in the area of water systems.

Area	Performance indicator	Unit
Resources	Water production capacity utilization	%
	Treatment plant capacity utilization	%
	Reuse supplied water	%
Storage	Raw water storage capacity	days
	Transmission and distribution storage capacity	days
Metering	Production and transmission meter density	No./plants
	District meter density	No./1000 connections
	Customer metering	%
SCADA	Facility automation degree	%
	Facility remote control degree	%

One section details remaining operations and additional maintenance indicators relevant for as shown in Table B 1-9.

Appendix Table 9 Proposed performance indicators in the area of O&M

Area	Performance indicator	Unit
Inspection and calibration	Pump inspection	%
	System valve inspection	%
	Reservoir cleaning	%
	Control valve inspection	%
	Network inspection	%
	Service connection inspection	%
	Instrument and inspection and calibration	%
	Systems flow meters calibration	%
	Pressure meters calibration	%
	Water level meters calibration	%
	Water quality sensor calibration	%
	Control unit inspection and calibration	%
	Electrical panel inspection	%
Rehabilitation and replacement	Mains rehabilitation and replacement	%
	Service connection rehabilitation and replacement	%
	System valve rehabilitation and replacement	%
	Control valve rehabilitation and replacement	%
	Pump rehabilitation and replacement	%
	System flowmeter rehabilitation and replacement	%
	Customer flowmeter rehabilitation and replacement	%
	Leaks repaired	No./100 km
Vehicles	Vehicle availability	No./100 km
	Vehicle availability	No./1000 customer
Customer metering	Customer meter reading efficiency	%
	Customers billed based on metering	%
Quality monitoring	Aesthetic tests carried out	%
	Microbiological tests carried out	%
	Physical-chemical tests carried out	%
	Radioactivity tests carried out	%

Of great importance, the IWA performance indicators for water supply services include a section on the quality of service as shown in Table B 1-10.

Appendix Table 10 Proposed performance indicators in the area of quality of service.

Code	Area	Performance indicator	Unit
QS01	Service coverage	Households and business supply coverage	%
QS02		Buildings supply coverage	%
QS03		Population coverage	%
QS04		Population coverage with service connections	%
QS05		Population coverage with public taps or standpipes	%
QS06	Public taps and standpipes	Operational water points	%
QS07		Average distance from water points to households	m
QS08		Per capita water consumed in public taps and standpipes	l/person/day
QS09		Population per public tap or standpipe	persons/day
QS10	Pressure and continuity of supply	Pressure of supply adequacy	%
QS11		Bulk supply adequacy	%
QS12		Continuity of supply	%
QS13		Water interruptions	%
QS14		Interruptions per connection	No./1000 connections
QS15		Bulk supply interruptions	No./delivery point
QS16		Population experiencing restrictions to water service	%
QS17		Days with restrictions to water service	%
QS18	Quality of supplied water	Quality of supplied water	%
QS19		Aesthetic tests compliance	%
QS20		Microbiological tests compliance	%
QS21		Physical-chemical tests compliance	%
QS22		Radioactivity tests compliance	%
QS23	Service connection and meter	New connection efficiency	days
QS24		Time to install a customer meter	days
QS25		Connection repair time	days
QS26	Customer complaints	Service complaints per connections	No./1000 connections
QS27		Service complaints per customer	No./customer
QS28		Pressure complaints	%
QS29		Continuity complaints	%
QS30		Water quality complaints	%
QS31		Interruption complaints	%
QS32		Billing complaints and queries	No./customer
QS33		Other complaints and queries	No./customer
QS34		Response to written complaints	%

And similarly, we propose a simpler section more relevant for the case of Lebanon as shown in Table B 1-11.

Appendix Table 11 Proposed performance indicators in the area of quality of service.

Area	Performance indicator	Unit
Coverage	Service coverage	%
	Unit supply coverage legally by WE	%
	Unit supply coverage by other entities	%
	Unit supply coverage by illegal connections	%
Continuity	Supply continuity	%
	Population receiving continuous supply	%
Water quality	Quality of supplied water	%
	Aesthetic tests compliance	%
	Microbiological tests compliance	%
	Physical-chemical tests compliance	%
	Radioactivity tests compliance	%
Response speed	Average response time to customer complaint	Hours
	New connection establishment time	days
	Time to install a customer meter	days
	Connection repair time	days
Customer complaints	Billing complaints and queries	No./1000 customer
	Service complaints per connections	No./1000 customer
	Pressure complaints	No./1000 customer
	Continuity and interruption complaints	No./1000 customer
	Water quality complaints	No./1000 customer

While not all these indicators will be relevant to decision makers at high levels, or can be currently calculated with sufficient accuracy, they offer a broad overview of the establishment's needs for the sake of this assessment. A selected list of Key Performance Indicators can then be extracted at the upcoming activity.

APPENDIX 2. Selection of assessment benchmarks

Benchmarks are needed to give the performance indicators meaning and value. When selecting benchmarks for different performance indicators and given that in most cases there remains a general lack of internationally approved standards giving exact figures to follow. Some exceptions may exist at this stage such as the following:

- ✓ Staff to connections:
  Tynan and Kingdom (2002) studied water utilities of different levels of performance and found that a staff size of 5 per 1000 connections was achievable by the top group of utilities. Since then, this figure has been adopted, and sometimes increased to express the size for utilities running both water and wastewater services.

- ✓ Non-Revenue Water as a ratio of system input volume (% NRW):
  While the IWA, AWWA, and the EU recommend against using this indicator as a target or a benchmark, Tynan and Kingdom found that 23% or less represents the performance level of the top performing utilities. We assess that a percentage can be used as a target when guided by other indicators such as ILI and ALI but not based on ad-hoc percentages. Also the percentage of NRW cannot be used to compare utility performance.
- ✓ Infrastructure Leakage Index (ILI):
  The ILI is recommended by the IWA, AWWA, and the EU as the indicator for benchmarking performance on physical (or real) loss performance. This indicator assesses the condition of leakage of infrastructure operating at a certain water pressure given its characteristics, and therefore assesses physical assets condition as well as the speed of repair of leaks, yet does not assess the performance in pressure management. Moreover, the results of ILI will vary widely based on assumptions about supply continuity and pressure in networks, neither of which are currently recorded in Lebanese WEs. Still, and since ILI is based on deviation from an ideal, the ideal of ILI for developed countries is the Unavoidable Annual Real Loss (UARL), while the ideal for developing countries is twice the UARL.
- ✓ Apparent Loss Index (ALI):
  The ALI is a simple indicator to calculate and is the ratio of commercial (or apparent) loss to 5% of the billed authorized consumption, here 5% representing the ideal for developed countries. For developing countries 10% is used, meaning that the target for commercial losses should be less than 10% of the billed quantities.
- ✓ Supply continuity:
  A major KPI, supply continuity is agreed to be a required objective by the international water organisations, and also referenced by Tynan and Kingdom. A 24/7 supply is an agreed-upon target, and fewer supply hours will jeopardise risk for both the conditions of the physical network assets and the health of the customer.
- ✓ Number of water quality samples from distribution networks:
  The Lebanese water quality standards provides detailed requirements for water quality testing. These tests can differ in the number of samples. The WHO on the other hand recommends one monthly sample for every 10,000 people serviced plus 10 additional samples. For a utility serving one million people this amounts to 1320 samples annually.

Otherwise, we followed the following principles:

- A benchmark can be more ambitious than an improvement target which is more concrete and can be used for accountability.
- A benchmark can start as a high ideal if impossible to achieve (e.g. 0% or 100%)
- A general direction of higher or lower may be used instead of a fixed value.
- Performance of basic tasks is expected to occur at least annually.

Strategically, more or less strict standards may need to be adopted as in the case of sensitive electronics used in SCADA may require stricter and more frequent control compared to regular network isolation valves. In either case, and given the status of maintenance that is expected in Lebanese WEs, any reference standard that can be established is preferable to the lack of one.

In some cases the performance indicators are not immediately tied to the efforts of the establishment or controlled by them. An example is the number of failures where better operation could indeed lead to fewer cases of failures, yet the number of cases will not be fully dependent on the level of effort and failures will eventually occur regardless.

The resulting benchmarks can therefore either be set as an ideal goal the WEs should aspire to reach, or a comparative assessment of achievement that can be compared between WEs or regions within the WE and will evolve with the evolution of performance.

SECTION C
FINANCIAL PERFORMANCE DIAGNOSIS

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C. 1 INTRODUCTION

Water utilities in Lebanon are public establishments created in year 2000, under Law 221, and fully implemented in 2005, that merged regional water authorities and committees into four water establishments.

By law, these establishments are independent, state owned water utilities, responsible for production, distribution, and billing for water, wastewater, and irrigation services, under the tutelage of the ministry of energy and water, that formulates policy and regulates fees.

As such, these establishments have to produce, ahead of each year, a balanced budget, to be approved by the ministry, and present externally audited financial results at the end of the year. In order to present a balanced budget, most establishments would overestimate revenues, and understate expenditures.

The water code law 77 – 2018 amended by law 192 – 2020, and still pending proposes a commercial approach to service delivery by separating water, waste water, and irrigation operations both technically and financially, and allowing for contracting service providers in limited areas within each territory: private operators, municipalities, or water committees.

If and when implemented, the water code would require modifications to the organizational structure of the establishments, and the adoption of generally accepted accounting principles, standards, and procedures, away from the currently used public accounting system.

To this end, many attempts have been made since 2005, mainly:

- To map, assess and evaluate fixed assets (identification, ownership, valuation, replacement cost, amortization…)
- Review and amendments to organization charts adopted in 2005.
- Implement a commercial accounting system : SAFEGE, X7/PIMS (2005-2009), USAID, ERP Msft Navision (2011 – to date).
- Tariff analysis that require the calculation of “cost of goods sold” was limited by determination of production volumes by water source, manpower and operation and maintenance costs corresponding to production facilities, and actual water consumption by billed customers.
- Survey of residents, beneficiaries, illegal connections.
- Pilot projects to address NRW : Bulk, district, and household water meters, SCADA system.

Not withstanding above, financial results of the water establishment has been reviewed with actual numbers provided, and constitute a starting point for planning for future activities.

Additionally, a cost recovery study has been performed using the numbers of the year 2019 as base values (before the economic crisis) to simulate the impact of the hyperinflation on the opex cost.

Therefore, section C is organized upon two main chapters:

- The first chapter presents a review of the actual financial numbers and figures of the WE where results will constitue the basis for planning for future activities.
- The second chapter summarises the main findings and key recommendations resulted from the cost recovery study

C. 2 REVIEW OF THE FINANCIAL SITUATION

C. 2.1 Book keeping and related matters

Book keeping is a matter of concern with some WEs far in advance and following good practices and due accounting principles, while others are not up to standards. For the latest, data are somehow unstable and confusing.

As far as financial reporting is concerned, the situation is somehow confusing with WEs maintaining in parallel two systems. The first is a requirement of the MoEW and is an administrative budget with authorization for payments and associated budgets. The second is more business oriented trying to meet financial commercial reporting standards.

The flaw is that the admin system is extremely time and effort consuming preventing the finance department to concentrate on the financial & commercial reporting systems.

The second flaw is sometimes financial reports are extracted from the admin budget and sometimes from the commercial ledgers. The two systems are not compatible and reconciliation of the two systems is cumbersome.

When it comes to financial data capture, the double entry principle is required for commercial ledgers but not for the budget presentation required by the ministry.

Meanwhile some WEs are in line with International Financial Reporting Standards (IFRS).

Table C 2-1 Balance sheet and statement of revenues and expenditures

	NLWE	SLWE	BWE	BMLWE
Balance sheet (Assets & liabilities)	Partial[1]	Yes	No	Yes[2]
Statement of revenues and expenditures	Yes	Yes	Yes[3]	Yes[4]

While only 2 WEs have a balance sheet recording assets and liabilities, other have partial records with assets registry incomplete or statement of revenues not properly recorded. The same applies to stock management and control. For instance, current revenues of a year might also include collected arrears from previous years.

Due to the dual accounting systems, the statement of revenues and expenditures is also unstable and questionable with some WE (BWE) not recording some key expenditures (Energy, taxes, out-sourced activities etc.). The same applies to subsidies which are included or not into the revenues.

In addition, it is worth mentioning that the grants of some donors are not, or improperly recorded in the books leading to a distorted vision of the situation. Many inconsistencies were

[1] Asset inventory not completed
[2] No free access to the balance sheet was given to the technical assistance
[3] Subject to clarification
[4] Subject to clarification

detected with confusion between accrued and cash revenues and confusion between opex and capex. In the same line of thought, payments of previous years are recorded in the current year conducting to inaccurate collection rate. The same applies to irrigation which is sometimes included in the revenues and opex and sometimes excluded.

Each WE has developed its own info system with no standards proposed/imposed by the MoEW. Thus comparisons, benchmarking, exchange of information, reconciliation and production of standard reports are questionable. At this point, it is worth mentioning that there is a tendency to use the Enterprise Resource Planning (ERP) which is an integrated package addressing the billing, collection, the accounting and assets management etc. Such package has been made available through USAID; however, this software has not been fully implemented, and sometimes produces doubtful reports.

Bookkeeping policy and procedures manuals are not available and financial statements are not audited except by “la Cour des Comptes” which concentrates on formal administrative issues and not on the core business and financial aspects. In other words, and despite a legal requirement, no chartered accountant is hired for the provision of auditing and ascertaining the accuracy and regularity of the financial statements.

On the organizational side, the customer management or commercial issue is not yet identified as a must and the billing/collecting is falling under the responsibility of the admin/finance manager or HR dpt. We are of the opinion that such absence is part of the culture in Lebanon whereby the final user is regarded as a subscriber but not as customer. Such statement does not apply in the specific case of SLWE where a customer’s affairs department is officially displayed in the organization chart.

Annual reports are produced by some WEs but no on a standardized form, with long delays in publication. Generally speaking, the annual report is a mix between existing situation, yearly activities and results, and future projects.

As a conclusion, the combination of incomplete and fuzzy commercial records and financial statements not up to standards does not allow to have a crystal-clear vision of the financial situation of the WEs. Such opinion is to be adjusted on a case-by-case basis.

Meanwhile, for the purpose of this exercise, the consultant has used its best endeavour in order to clarify and depict a reasonable financial & commercial situation of the WEs.

As a consequence, all figures, ratios and calculations displayed in the report reflect “our best estimates”.

C. 2.2 Methodology

For the purpose of this exercise our methodology is based on the collection and display of key data encompassing technical, commercial and financial pieces of information. The objective is to combine these data, produce some relevant ratios for displaying a clear picture of the situation of the WE.

Table C 2-2 Key figures

Key figures	Unit
Nbr. of customers	Nbr.
Of whom water meters	"
Volume produced & entering into the system	m^3/year
Volume billed/subscribed	m^3/year
Est. NRW rate	%
Accrued revenues (including Irrigation)	LBP
Annual collection rate	%
Actual revenues of the year	LBP
Operating cost	"
Operating result (EBITDA)	"
EBITDA in %	%
Operating result while taking the collection rate (EBITDA)	LBP
EBITDA in % while taking the collection rate	%
Cash situation end of the year	LBP
Receivables end of the year	"
Est. Amortization	"
Average selling price/m^3	LBP
Average collected /m^3	"
Operating cost /m^3	"

Subject to availability of the data, all pieces of information are to be collected throughout many fiscal years for trend identification purpose.

Table C 2-3 Fiscal years for each WE

	Fiscal years
BMLWE	2016 – 2020
BWE	2008 – 2020
SLWE	2017 – 2020
NLWE	2017 – 2020

Meanwhile, throughout this exercise, we will highlight the particulars of the WE and stress strengths and weaknesses. Whenever relevant, explanatory graphs are displayed.

On the financial side, we concentrated on profitability, liquidity and solvency of the WE. A particular attention is paid to the EBITDA (Earnings Before Interest, Tax, Depreciation & Amortization) which reflects the profitability of the business together with the capacity to produce sufficient cash-flow. Such concept refers more or less to the French “Marge Brute”.

C. 2.3 Results of the financial review

C. 2.3.1 Opinion on quality, accuracy and consistency of data collected

Generally speaking, most of the data are not extracted from the general ledger but from journals, financial statements, and reports produced different accounting modules.

C. 2.3.2 Key figures

In the following, we present the key figures we collected from BWE for the period between the year 2008 and the year 2020.

The key figures as collected from BWE are as follow:

- Number of customers
- Customers with water meters
- Volume produced
- Volume billed
- Non-Revenue Water (NRW)
- Accrued revenues (turn over)
- Annual collection rate
- Actual revenues
- Operating cost
- Operating result
- Cash situation
- Receivables end of the year
- Amortization/Depreciation.

The table below includes, in addition to the above, some calculated figures as the average selling price of m^3, the average collected per m^3, and the operating cost per m^3

Table C 2-4 Key figures for BWE

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Nb of customers	Nber	64,650	66,095	68,473	72,240	75,239	77,334	79,030	81,726	83,837	85,111	86,761	87,979	88,983
Of whom water meters	"	19,878												32,401
Volume produced & entering into the system	m³/ year	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	68,000,000	56,000,000	53,981,983	53,670,099	53,183,820
Volume billed/subscribed	m³/ year	26,754,135	27,352,370	28,336,410	29,895,325	31,136,325	32,003,200	32,705,095	33,820,900	34,694,710	35,221,770	35,904,685	36,408,750	36,824,120
Est. UFW rate	%	61%	60%	58%	56%	54%	53%	52%	50%	49%	37%	33%	32%	31%
Accrued revenues (including Irrigation)	LBP	12,398,315,600	12,675,438,000	12,829,966,000	13,991,980,000	14,388,588,000	19,065,449,000	19,822,238,000	20,129,313,000	22,869,195,332	23,976,962,624	24,290,499,933	24,964,880,799	25,431,943,516
Annual collection rate	%	38%	38%	50%	61%	63%	57%	54%	52%	43%	47%	51%	46%	45%
Actual revenues of the year	LBP	4,667,305,724	4,876,542,980	6,478,425,639	8,513,209,025	9,112,388,851	10,821,174,302	10,778,015,743	10,567,191,985	9,941,114,740	11,202,188,509	12,435,463,000	11,559,948,750	11,434,634,913
Operating cost	"	11,910,413,106	11,640,334,946	12,091,821,000	13,479,927,665	15,995,695,962	16,179,609,304	17,784,759,813	16,738,348,097	17,277,000,471	21,152,223,323	20,597,113,526	22,579,090,177	21,202,970,717
Operating result (EBITDA)	"	487,902,494	1,035,103,054	738,145,000	512,052,335	-1,607,107,962	2,885,839,696	2,037,478,187	3,390,964,903	5,592,194,861	2,824,739,301	3,693,386,407	2,385,790,622	4,228,972,799
EBITDA in %	%	4%	8%	6%	4%	-11%	15%	10%	17%	24%	12%	15%	10%	17%
Operating result while taking the collection rate(EBITDA)	LBP	-7,243,107,382	-6,763,791,966	-5,613,395,361	-4,966,718,640	-6,883,307,111	-5,358,435,002	-7,006,744,070	-6,171,156,112	-7,335,885,731	-9,950,034,815	-8,161,650,526	-11,019,141,427	-9,768,335,804
EBITDA in % while taking the collection rate	%	-155%	-139%	-87%	-58%	-76%	-50%	-65%	-58%	-74%	-89%	-66%	-95%	-85%
Cash situation end of the year	LBP			1,553,429,138	12,202,263,154	17,285,125,912						12,514,369,412	7,463,218,238	2,853,610,278
Receivables end of the year	"	67,435,634,000	75,234,529,000	81,586,069,000	87,064,840,000	92,341,039,000	100,585,314,000	110,147,435,000	123,075,516,000	135,850,290,000	147,705,327,000	161,110,259,000	175,107,567,000	189,104,875,603
Average selling price/m³	LBP	463	463	453	468	462	596	606	595	659	681	677	686	691
Average collected /m³	"	174	178	229	285	293	338	330	312	287	318	346	318	311
Operating cost / m³	"	445	426	427	451	514	506	544	495	498	601	574	620	576

Data highlighted in yellow has not been made available.

Of great importance is the comparison of the average collected per m3 and the operating cost per m3. It can be seen for the period between the year 2008 and the year 2020 that BWE is not able to recover the operating cost per m3 and to make profits. It is to be noted that the subject of cost recovery is detailed in chapter 2.

C. 2.3.3 Comments on key figures

The following summarizes the issues we identified:

- Water meters are not read for volumetric consumption, and are billed at the flat yearly rate. The extracted value identifies only the type of subscription. BWE didn't add the number for each year since the extracted values will not reflect the yearly situation of the number of water meters.
- Due to uncertainties regarding volume produced and entering into the system, the NRW rate must be taken with care.
- Production before 2017 is based on estimates. After 2017 production decreased due to power shortage.

Table C 2-5 Financial Situation of BWE

	Fiscal year 2019		Fiscal year 2020	
	Accrued	Actual	Accrued	Actual
Turn over	24,964,880,799		25,431,943,516	
Subsidies				
Total actual revenues	24,964,880,799	11,559,948,750	25,431,943,516	11,434,634,913
Other Operating cost	-10,646,542,433		-11,048,991,475	
Personnel	-11,932,547,744		-10,153,979,242	
EBITDA	2,385,790,622	-11,019,141,427	4,228,972,799	-9,768,335,804
Amortization	NA			
Operating result				
Other revenues/expenditures				
Cost of debt				
Net result				

The situation of BWE can be briefly depicted as follows:

- The WE is in a very bad situation and relies on subsidies provided by the MoEW, and on donors for small projects, emergency maintenance, and consumables.
- The EBITDA is in the negative territory which means that the price of water combined with the collection rate and number of subscribers (very low compared with population supplied) cannot match the operating costs.

As a consequence :

- The account receivables in 2020 is worth 7 times the accrued turn over (Figure C 2-2).
- The cash situation is rather alarming (Figure C 2-1)
- The collection rate has a declining trend (Collection rate spike in 2012 is due to penalties reduction and payment of overdue amounts by instalments
- Although theoretically, the average selling price can meet the operating cost, the poor collection rate does not allow to loop and balance the account. In addition, the O & M cost for 1 m^3 is likely to increase in 2021 due to exchange rate, and bridging the gap with an unchanged tariff is definitely impossible (Figure C 2-3)

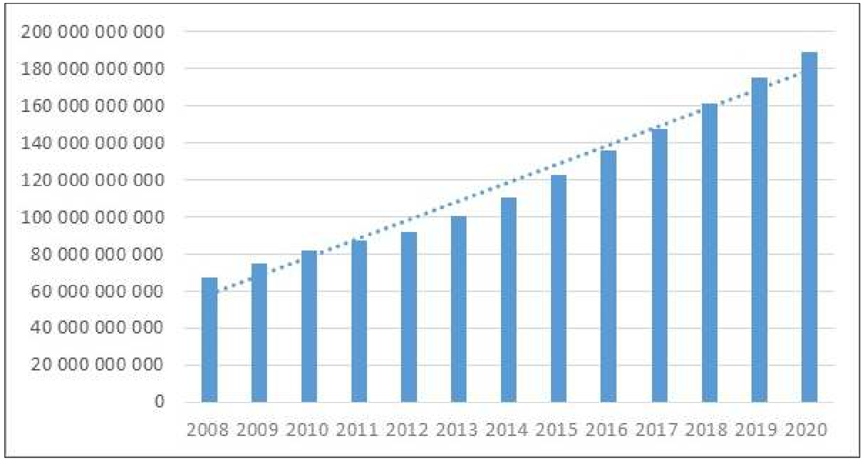

Figure C 2-2 Account Receivables

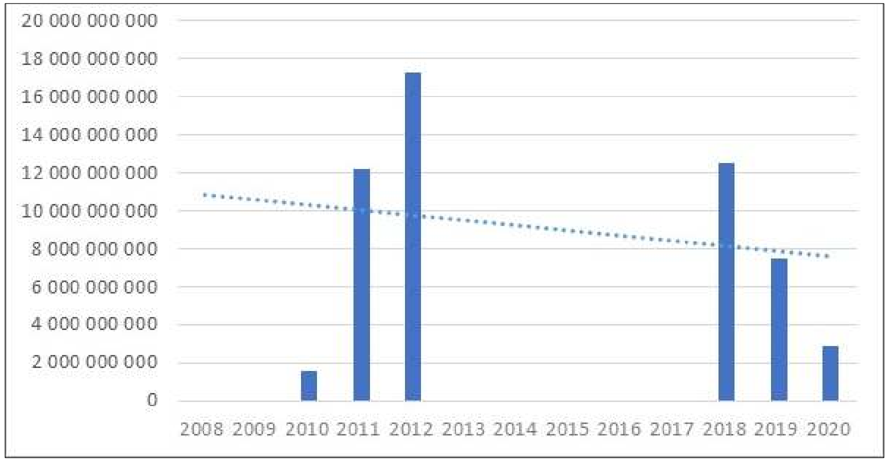

Figure C 2-1 Cash situation (End of year)

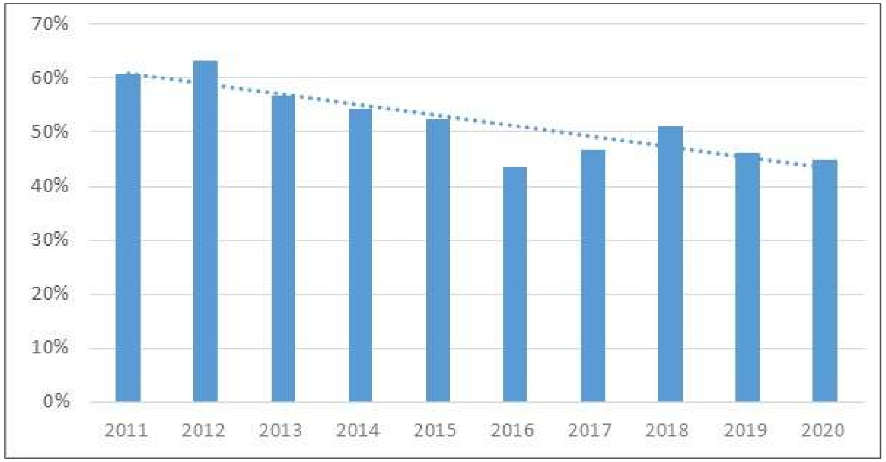

Figure C 2-4 Collection rate

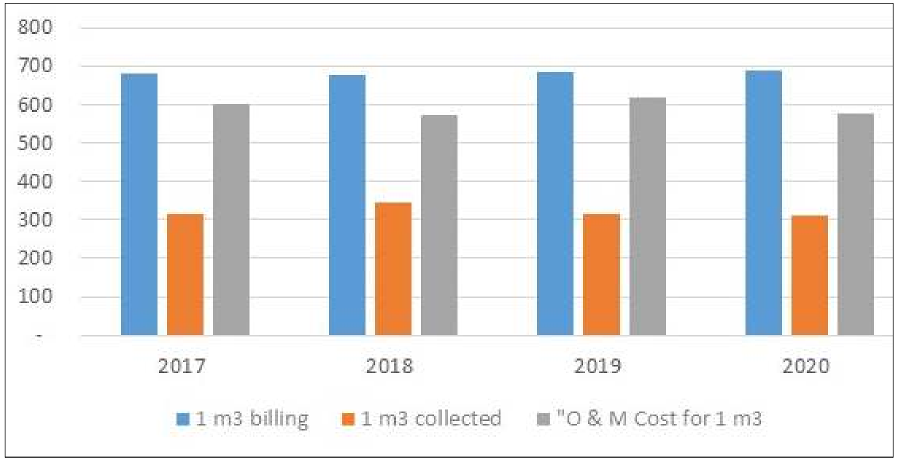

Figure C 2-3 Price and cost of 1 m³

C. 3 COST RECOVERY

C. 3.1 Definition

Cost recovery is the ratio of expenses over cash flow.

Expenses include all operational expenditures (Opex) and asset depreciation expenditures (Capex). However, under this study, Capex are not considered because :

- No data is available about the asset value of any of the four WE. This is one of the issues to be addressed in the future.
- Due to the present financial situation, the WEs are pretty much far from achieving Opex recovery. Their major challenge is to be able (and get the means) to implement required measures to gradually improve cost recovery, in order to achieve balance in the coming five or six years.

Therefore, in this study by *Cost Recovery* it is meant *Opex Cost recovery*.

C. 3.2 Cost recovery and the impact of the financial crisis

Table C 3-1 below shows the cost recovery ratios based on the financial situation that was prevailing in 2019, when the exchange rate USD/LBP was stable, and based on the water tariff in force then. It can be seen that BWE was achieving 44% Opex recovery. Opex balance would have been achieved without tariff change if the Collection and the Revenue Water rates were brought up to 85%.

Table C 3-1 Opex recovery analysis (2019 financial situation)

Operational Revenues : 24 965 M LBP		Cash Flow : 10 288 M LBP		Total OPEX : 23 150 M LBP	
Financial Indicators (Base value)		**Collection rate assessment**		**OPEX Breakdown**	
Exchange Rate :	1 500 LBP/USD	Invoiced :	24 965 M LBP	HR	8 402 M LBP
Fuel :	850 LBP/l	Collected :	10 288 M LBP	Power	7 795 M LBP
Gazoline :	25 000 LBP/20 l	Collection Rate	41%	EDL	5 865 M LBP
Transportation :	8 000 LBP/day	Cost recovery	44%	EDZ	1 180 M LBP
Kwh from EDL :	84%			Generators	750 M LBP
Kwh from EDZ :	8%	**Subscriptions rate assessment**		Donations	0 M LBP
Kwh from Gen. :	8%	Volume Produced	53 670 K m³	Consumables	740 M LBP
EDL increase factor :	1.00	Volume Billed	35 400 K m³	Paid by WE	680 M LBP
EDZ increase factor :	1.00	Technical losses	8% (ILI = 8)	Donations	60 M LBP
CPI :	115	Subscriptions Rate	71%	O&M	4 637 M LBP
Salaries increase factor :	1.00	Potential invoicing	34 938 M LBP	Paid by WE	4 637 M LBP
Including new WWTPs :	No			Donations	- - M LBP
				Administrative	1 576 M LBP
Tariff increase factor :	1.00	(Avg. bill amount : 271 000 LBP)			

SUBSCRIPTION RATE (rows) / **CONSUMABLES RECOVERY RATE** (columns)

TOTAL OPEX RECOVERY RATE

Amount to recover : 23 150 M LBP

	41%	45%	49%	53%	57%	61%	65%	69%	73%	76%	80%	84%	88%	92%	96%	100%
71%	44%	49%	53%	57%	61%	66%	70%	74%	78%	82%	87%	91%	95%	99%	104%	108%
73%	46%	50%	54%	59%	63%	67%	72%	76%	80%	85%	89%	94%	98%	102%	107%	111%
76%	47%	51%	56%	60%	65%	69%	74%	78%	83%	87%	92%	96%	101%	105%	110%	114%
78%	48%	53%	57%	62%	67%	71%	76%	80%	85%	90%	94%	99%	103%	108%	112%	117%
80%	50%	54%	59%	64%	68%	73%	78%	82%	87%	92%	97%	101%	106%	111%	115%	120%
82%	51%	56%	60%	65%	70%	75%	80%	85%	89%	94%	99%	104%	109%	114%	118%	123%
84%	52%	57%	62%	67%	72%	77%	82%	87%	92%	97%	102%	107%	111%	116%	121%	126%
86%	53%	58%	63%	69%	74%	79%	84%	89%	94%	99%	104%	109%	114%	119%	124%	129%
88%	55%	60%	65%	70%	75%	81%	86%	91%	96%	101%	106%	112%	117%	122%	127%	132%
90%	56%	61%	66%	72%	77%	82%	88%	93%	98%	104%	109%	114%	120%	125%	130%	136%
92%	57%	63%	68%	73%	79%	84%	90%	95%	101%	106%	111%	117%	122%	128%	133%	139%
94%	58%	64%	69%	75%	81%	86%	92%	97%	103%	108%	114%	119%	125%	131%	136%	142%
96%	60%	65%	71%	77%	82%	88%	94%	99%	105%	111%	116%	122%	128%	133%	139%	145%
98%	61%	67%	73%	78%	84%	90%	96%	101%	107%	113%	119%	125%	130%	136%	142%	148%
100%	62%	68%	74%	80%	86%	92%	98%	104%	110%	115%	121%	127%	133%	139%	145%	151%

However, everything has changed since. The financial crisis had major impact on Opex while the cash flow is still the same as no tariff adjustment is made to date.

Table C 3-2 below shows the cost recovery analysis based on the financial indicators of 2022.

The EDL tariff of 2019 is multiplied by 13 in 2022. This figure is calculated based on the following assumptions :

- EDL tariff in 2019 : 170 LBP/kWh. this is the average rate charged by EDL for the WEs, including subscriptions and else, but not including VAT.
- EDL tariff for the first six months of 2022 will remain unchanged (same as 2019)
- EDL tariff for the second half of2022 will be raised to 0.21USD (according to a verbal communication from MoEW)
- Exchange rate + 20 000 LBP/USD as per *Manassa*h platform.

Table C 3-2 Opex recovery analysis (2022 financial situation)

Operational Revenues : 24 965 M LBP		Cash Flow : 10 288 M LBP		Total OPEX : 224 791 M LBP	
Financial Indicators (Typical 2022)		**Collection rate assessment**		**OPEX Breakdown**	
Exchange Rate (base = 1 500) :	20 000 LBP/USD	Invoiced :	24 965 M LBP	HR	22 094 M LBP
Fuel (base = 850) :	19 700 LBP/l	Collected :	10 288 M LBP	Power	123 371 M LBP
Gazoline (base = 25 000) :	375 000 LBP/20 l	Collection Rate	41%	EDL	82 468 M LBP
Transportation (base = 8 000) :	64 000 LBP/day	Cost recovery	5%	EDZ	22 460 M LBP
Kwh from EDL (base = 84%) :	84%			Generators	18 442 M LBP
Kwh from EDZ (base = 8%) :	8%	**Subscriptions rate assessment**		Donations	0 M LBP
Kwh from Gen. (base = 8%) :	8%	Volume Produced	53 670 K m^3	Consumables	10 066 M LBP
EDL increase factor :	13.00	Volume Billed	35 400 K m^3	Paid by WE	10 006 M LBP
EDZ increase factor :	20.00	Technical losses	8% (ILI = 8)	Donations	60 M LBP
CPI (base = 115) :	700	Subscriptions Rate	71%	O&M	59 666 M LBP
Salaries increase factor :	2.00	Potential invoicing	34 938 M LBP	Paid by WE	59 666 M LBP
Including new WWTPs :	Yes			Donations	- - M LBP
				Administrative	9 594 M LBP
Tariff increase factor :	1.00	(Avg. bill amount : 271 000 LBP)			

SUBSCRIPTION RATE / **CONSUMABLES RECOVERY RATE** / **TOTAL OPEX RECOVERY RATE** — Amount to recover : 224 791 M LBP

Subscription rate	41%	45%	49%	53%	57%	61%	65%	69%	73%	76%	80%	84%	88%	92%	96%	100%
71%	5%	5%	5%	6%	6%	7%	7%	8%	8%	8%	9%	9%	10%	10%	11%	11%
73%	5%	5%	6%	6%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	11%	11%
76%	5%	5%	6%	6%	7%	7%	8%	8%	9%	9%	9%	10%	10%	11%	11%	12%
78%	5%	5%	6%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%
80%	5%	6%	6%	7%	7%	8%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%
82%	5%	6%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%
84%	5%	6%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%
86%	5%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%	13%
88%	6%	6%	7%	7%	8%	8%	9%	9%	10%	10%	11%	12%	12%	13%	13%	14%
90%	6%	6%	7%	7%	8%	8%	9%	10%	10%	11%	11%	12%	12%	13%	13%	14%
92%	6%	6%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	13%	13%	14%	14%
94%	6%	7%	7%	8%	8%	9%	9%	10%	11%	11%	12%	12%	13%	13%	14%	15%
96%	6%	7%	7%	8%	8%	9%	10%	10%	11%	11%	12%	13%	13%	14%	14%	15%
98%	6%	7%	7%	8%	9%	9%	10%	10%	11%	12%	12%	13%	13%	14%	15%	15%
100%	6%	7%	8%	8%	9%	9%	10%	11%	11%	12%	12%	13%	14%	14%	15%	16%

The financial situation of BWE – yet not comfortable in 2019 – is now critical.

It is mandatory to adopt a realistic tariffs policy, together with the necessary efforts to improve the Revenue Water and Collection rates. Table C 3-3 below shows the required tariff for Opex recovery, for various scenarios.

Table C 3-3 Required tariff revision (2022 financial situation)

Assuming unchanged Collection and Subscriptions rates														
Cost recovery rate	5%	12%	19%	27%	34%	41%	49%	56%	63%	71%	78%	85%	93%	100%
Tariff increase factor	1	2.60	4.21	5.81	7.42	9.02	10.62	12.23	13.83	15.43	17.04	18.64	20.25	21.85
Required bill amount for 100% Cost recovery : 5 380 000 LBP														
Assuming 100% Collection; Subscriptions unchanged														
Cost recovery rate	11%	18%	25%	32%	38%	45%	52%	59%	66%	73%	79%	86%	93%	100%
Tariff increase factor	1	1.62	2.23	2.85	3.46	4.08	4.69	5.31	5.93	6.54	7.16	7.77	8.39	9.00
Required bill amount for 100% Cost recovery : 2 220 000 LBP														
Assuming 100% Collection and Subscriptions														
Cost recovery rate	16%	22%	29%	35%	42%	48%	55%	61%	68%	74%	81%	87%	94%	100%
Tariff increase factor	1	1.42	1.84	2.25	2.67	3.09	3.51	3.93	4.34	4.76	5.18	5.60	6.02	6.43
Required bill amount for 100% Cost recovery : 1 580 000 LBP														

C. 3.3 Action for Opex recovery

Due to the present social and financial situation, it is a fact that the WEs cannot achieve much in regard to improving the Collection and Revenue Water rates.

Figure C 3-1 below gives a possible (and plausible) progress that BWE can undertake regarding Collection and Revenue water improvement, in addition to tariff increase, in order to achieve Opex balance within the coming 5 years.

The proposed figures for progressive improvement in Collection and Revenue Water are set after discussion with the financial and technical departments of the WE. These, in their opinion, are realistic figures to be achieved.

Tariff increase requires political consensus in order for the WE to be allowed to gradually increase the tariff to the adequate level.

		Simulated, based on Dec. 2021 financial data (see table below)					
	2019	2021	2022	2023	2024	2025	2026
Collection rate	41%	31.71%	37% (+5%)	43% (+6%)	51% (+8%)	59% (+8%)	67% (+8%)
Subscriptions rate	71%	71%	75% (+4%)	79% (+4%)	83% (+4%)	87% (+4%)	91% (+4%)
Tariff increase factor	1.00	1.00	6.10 (+510%)	7.32 (+20%)	10.16 (+39%)	12.20 (+20%)	14.76 (+21%)
Bill amount (for 1 m³/day, gauged)	**246 000 LBP**	**246 000 LBP**	**1 500 000 LBP**	**1 800 000 LBP**	**2 500 000 LBP**	**3 000 000 LBP**	**3 630 000 LBP**
2019 Revenue increase factor	1.00	1.00	7.45	10.96	18.98	27.63	39.73
Cost Recovery	44%	3.52%	26%	39%	67%	97%	140%
Cash flow/Opex Balance	**-12 862 M LBP** (-8.6 M$)	**-216 875 M LBP** (-10.8 M$)	**-165 781 M LBP** (-8.3 M$)	**-138 038 M LBP** (-6.9 M$)	**-74 529 M LBP** (-3.7 M$)	**-6 025 M LBP** (-0.3 M$)	**89 743 M LBP** (4.5 M$)
Cash flow/Opex Balance in case unchanged collection and subscription rates	**-12 862 M LBP** (-8.6 M$)	**-216 875 M LBP** (-10.8 M$)	**-176 520 M LBP** (-8.8 M$)	**-166 866 M LBP** (-8.3 M$)	**-144 340 M LBP** (-7.2 M$)	**-128 250 M LBP** (-6.4 M$)	**-107 976 M LBP** (-5.4 M$)

	Financial data	
	2019	Simulated
Exchange Rate :	1 500 LBP/USD	20 000 LBP/USD
Diesel cost	850 LBP/litre	19 700 LBP/litre
gazoline cost	25 000 LBP/20 litre	375 000 LBP/20 litre
Transportation :	8 000 LBP/day	64 000 LBP/day
Energy produced from EDL	84% EDL	84% EDL
EDL increase factor :	--	13.0 x 2019 rate
CPI	115	700
Salaries increase factor :	--	2.0 x 2019 rate
OPEX		**224 791 M LBP**

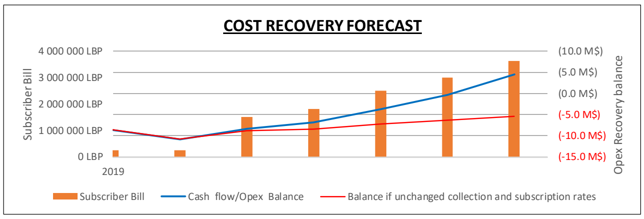

Figure C 3-1 Plausible gradual improvement in order to achieve Opex balance

C. 4 MAJOR RECOMMENDATIONS

In 2021 in the context of hyperinflation, the picture will probably deteriorate with revenues declining and O & M costs up rising.

Financially there is a risk that the public utility to be squeezed and quality of the service deteriorating.

The recovery of the WEs is at stake with, first of all, an adjustment to the tariff level and this is to be addressed urgently.

As a result of the financial performance diagnosis, the WE shall take into consideration the following recommendations:

C. 4.1.1 Short term

There is an urgent need to adjust the water tariff level in 2022 to ensure that the WE remain operational in 2022. It is likely that due to the high rate of inflation in 2021, and the exchange rate on equipment and spare parts, operating costs will increase to a level the WEs cannot afford.

- Conduct a study to assess the weak collection efficiency and the inadequate customer records with focus on the reliance on contractual collectors (contract terms, remuneration, number of collectors and performance targets)
- Carry out studies for the assessment of the existing billing and payment processing system and the possibility of the introduction of improved billing technologies, with the view of future integration within a central digitalization system.
- Strengthen the geographic information system mapping to cover the subscribers' data and the records of properties showing all potential water customers.
- Undertake an economic analysis of production and cost, taking into consideration the short-run and long-run to allow for a comprehensive pricing strategy that would allow to gradually recover the operational costs and eventually any future capacity expansion.
- Establish a tariff setting scheme and tariff reforms with mechanisms for obtaining the information on present and future costs of operation and mechanisms of indexation to adjust tariffs by inflation, energy prices and other items that are part of the cost schedule of BWE.
- Prepare a plan for recovery of outstanding debts. Such issue is to be addressed through an internal task force with possibility to compromise and reduce the debt against a down final payment. Such action's objective is to provide cash to the WE. This will require to produce an historical listing of all debtors and sort them by category and prepare an action plan for that particular purpose. Such difficult action can be made with internal resources of the WE or it can be outsourced.

C. 4.1.2 Mid/long term

- Prepare a standardized format for the annual report for the WE. The design and template should be made available through the TA and a consulting firm is to assist for implementation.
- Review and streamline all financial & bookkeeping procedures and standard chart of accounts through the WE with a long-term view to have the utilities audited by a first rank auditing firm.
- Reinforce in the WE the concept of NRW monitoring together with generalization of production/district metering.

SECTION D
DATA COLLECTED

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D.1 BASIS AND PRINCIPLES OF DATA COLLECTION

The goal of this assessment is beyond performance evaluation or data collection as it also includes the simulation of a supervisory or regulatory audit and answer the following questions:

- How easily can an audit take place?
- What data is available and what data is not and therefore requires capacity building for improving?
- Which systems are producing good data and which systems need improvement?
- Can the WEs be benchmarked against each other and against international standards?
- Can the sub-regional department within the WE be used as bases of comparison?

Therefore, the process takes the shape of data collection but also investigates:

- Data sources available and systems producing data.
- Reliability and completion of said data.
- Accuracy in producing good targets and performance indicators for the supervisor or regulator.

The range period targeted was mainly the past five years from 2016-2020. However, when possible, data ranges from 2015 were taken. Often the only available information was the current 2021 which sometimes can be used as an estimate for 2020.

Although rarely, some information was available or could be calculated as an annual trend. This trend containing the years 2020 and/or 2021, and given that these years witnessed health and currency crises affecting revenues, power availability, data quality, and even human resources, these years would provide useful information but not one that can represent the past or future of the water establishments.

In the subsequent sub-sections are detailed some common methods used for data collection in different areas.

D.1.1 HUMAN RESOURCES

Human resources and personnel data is vital for evaluating the current performance and planning improvements. However, for the WE under examination, the current staffing arrangements do not reflect a normal mode of operation. The WE hasn’t been able to freely hire or fire personnel and make up for this deficiency by promoting the responsibilities of current staff to fill the gap in authority to approve and conduct transactions, while procuring on-demand services to cover the shortage in manpower. Therefore, the analysis would benefit from both evaluating the current personnel situation as well as the situation that was envisioned in the WE by-laws.

The basis for data collection was the IWA water utility performance indicators and the needed variables. To prepare for the analysis in the field of human resources, we set out by seeking the following data variables as needed for the IWA performance indicators for water supply services as follows:

Table D 1-1 IWA recommended variables related to personnel

Code	Variable	Unit
B1	Total personnel	No.
B2	General management personnel	No.
B3	Human resource management personnel	No.
B4	Financial and commercial personnel	No.
B5	Customer service personnel	No.
B6	Technical service personnel	No.
B7	Planning and construction personnel	No.
B8	Operations and maintenance personnel	No.
B9	Water resources and catchment management personnel	No.
B10	Abstraction and treatment personnel	No.
B11	Transmission, storage and distribution personnel	No.
B12	Water quality monitoring personnel	No.
B13	Meter management personnel	No.
B15	University degree personnel	No.
B16	Basic education personnel	No.
B17	Other qualification personnel	No.
B18	Total training time	Hours
B19	Internal training time	Hours
B20	External training time	Hours
B21	Working accidents	No.
B22	Absenteeism	Days
B23	Absenteeism due to accidents or illness at work	Days
B24	Absenteeism due to other reasons	Days
B25	Working time	Hours
B26	Overtime work	Hours

However, due to the specific situation of the Lebanese WEs, the adjusted table, more in line with the local context, was produced (see Table D 1-2 below).

Since the current personnel situation in the WE is abnormal due to restrictions on hiring, many of the employees are being assigned different jobs than those they were hired for. Reliance on personnel contracts, the by-laws detailing the staff for the WE provide most information that can be assessed to answer the question of: Is the official organizational diagram in accordance to the needs of service and performance?

Table D 1-2 Revised variables related to personnel

By business		By job type	
Variable	Unit	Variable	Unit
Total personnel	No.		
Customer services	No.	Auxiliary - Clerical	No.
Distribution	No.	Auxiliary - Driver	No.
Engineering	No.	Auxiliary - Office boy	No.
Facilities	No.	Auxiliary - Guard	No.
Finance	No.	Collector / Reader	No.
General	No.	Customer Service	No.
HR	No.	Financial / Administrative	No.
Water quality	No.	Management	No.
		Management (Eng.)	No.
		Technical - Driver	No.
		Technical - Engineer	No.
		Technical - Laborer	No.
		Technical - Other	No.
		Technical - Water Quality	No.

D.1.2 TECHNICAL DATA

Technical data needed relates to water system assets as well as operational variables related to water loss, energy use, and water quality. The basis for data collection was again the IWA water utility performance indicators and the needed variables. However, changes were made to accommodate the lack of data as well as the particulars of the situation in Lebanon. We set out to collect variables from several categories.

D.1.2.1 Water resources

One category of interest is water resources which lists variables recommended by IWA (seeTable D 1-3 below).

Also related is the group of physical asset variables related to water systems (see Table D 1-4 below).

Table D 1-3 IWA recommended variables related to water resources.

Code	Variable	Unit
A01	Annual yield capacity of own resources	m^3
A02	Maximum allowance of raw and treated water importation	m^3
A03	System input volume	m^3
A04	Maximum water treated daily	m^3/day
A05	Exported raw water	m^3
A06	Water produced	m^3
A07	Exported treated water	m^3
A08	Billed metered consumption	m^3
A09	Billed unmetered consumption	m^3
A10	Billed authorized consumption	m^3
A11	Unbilled metered consumption	m^3
A12	Unbilled unmetered consumption	m^3
A13	Unbilled authorized consumption	m^3
A14	Authorized consumption	m^3
A15	Water losses	m^3
A16	Unauthorized consumption	m^3
A17	Metering inaccuracies water losses	m^3
A18	Apparent losses	m^3
A19	Real losses	m^3
A20	Revenue water	m^3
A21	Non-Revenue water	m^3
A22	Reuse supplied water	m^3

Table D 1-4 IWA recommended variables related to physical water assets.

Code	Variable	Unit
C01	Raw water storage capacity	m^3
C02	Treated water storage capacity	m^3
C03	Daily treatment capacity	m^3
C04	Pumps	No.
C05	Pumping stations	No.
C06	Pumping stations capacity	kW
C08	Mains length	km
C09	Distribution main length	km
C10	System flow meters	No.
C11	District meters	No.
C12	Pressure meters	No.
C13	Water level meters	No.
C14	On-line water quality monitoring instruments	No.
C15	Control units	No.
C16	Automated control units	No.
C17	Remotely controlled units	No.
C18	Emergency power systems	No.
C19	Signal transmission equipment	kW
C20	Electrical switchgear	No.
C21	Main valves	No.
C22	Isolating valves	No.
C23	Hydrants	No.
C24	Service connections	No.
C25	Average service connection length	m

For the situation at hand, the proposed variables highly match the needs of technical assessment, yet additional details were needed for these categories due to their importance for the assessment and the Lebanese WEs and not from any assumptions about the availability of such details.

Table D 1-5 Additional variables related to water resources and water resource assets.

Variable	Unit
Number of water supply systems	No.
Wells	No.
Springs	No.
Dams	No.
Treatment plants	No.
Wells daily production capacity	m^3
Springs daily production capacity	m^3
Dams daily production capacity	m^3

D.1.2.2 Operations

For the operations side, already partially covered, Table D 1-6 shows the IWA recommended variables related to energy. Yet a simpler and more relevant set of variables was adopted (Table D 1-7).

Table D 1-6 IWA recommended variables related to energy

Code	Variable	Unit
D01	Pumping energy consumption	kWh
D02	Maximum daily pumping energy consumption	kWh
D03	Standardization factor	m^3x100m
D04	Reactive energy consumption	kVA
D05	Energy recovery	Wh

Table D 1-7 Proposed variables related to energy use

Performance Indicator	Unit
Pumping energy consumption	kWh
Energy consumed from grid	kWh
Energy generated from fuel	kWh
Renewable energy generation	kWh
Energy recovery	kWh

In terms of inspection and maintenance, Table D 1-8 shows the IWA recommended set of variables; while Table D 1-9 shows the and more relevant set adopted.

Table D 1-8 IWA recommended variables related to Inspection & Maintenance

Code	Variable	Unit
D06	Pumping inspection (power of inspected pumps)	kWh
D07	Storage tank cleaning (volume of cleaned tanks)	m^3
D08	Network inspection	km
D09	Leakage control (Length of network in DMAs)	km
D10	Leaks repairs due to active leakage control	No.
D11	Hydrant inspection	No.
D12	System flow meter calibration	No.
D13	Pressure meter calibration	No.
D14	Water level meter calibration	No.
D15	On-line water quality monitoring equipment calibrations	No.
D16	Emergency power systems inspection	kW
D17	Signal transmission equipment inspection	No.
D18	Electrical switchgear inspection	No.
D19	Permanent vehicles	No.
D20	Mains rehabilitation	km
D21	Mains renovation	km
D22	Mains replacement	km
D23	Replaced valves	No.
D24	Service connection rehabilitation	No.
D25	Pumps overhaul (power of overhauled pumps)	kW
D26	Pump replacement	kW
D27	Pump failures	days
D28	Mains failures	No.
D29	Service connection failures	No.
D30	Hydrant failures	No.
D31	Power failures	hour
D32	Water-point failures	No.

Table D 1-9 Proposed variables for inspection and maintenance

Variable	Unit
Pump inspection	No.
System valve inspection	No.
Control valve inspection	No.
Reservoir cleaning	m^3
Network inspection	km
Service connection inspection	No.
Instrument and inspection and calibration	No.
Replaced valves	No.
Mains rehabilitation and replacement	km
Service connection rehabilitation and replacement	No.
System valve rehabilitation and replacement	No.
Control valve rehabilitation and replacement	No.
Pump rehabilitation and replacement	No.
System flowmeter rehabilitation and replacement	No.
Customer flowmeter rehabilitation and replacement	No.
Leaks repaired	No.

D.1.2.3 Water quality

The IWA recommended variables related to water quality are highly relevant for this assessment and future performance evaluation. One missing issue is the required number of samples; but this may be set in due time, based on the number of water quality personnel.

Table D 1-10 IWA recommended variables related to water quality

Code	Variable	Unit
D46	Required treated water quality tests carried out	No.
D47	Required aesthetic tests carried out	No.
D48	Required microbiological tests carried out	No.
D49	Required physical-chemical tests carried out	No.
D50	Required radioactivity tests carried out	No.
D51	Treated water quality tests carried out	No.
D52	Water quality tests carried out	No.
D53	Aesthetic tests carried out	No.
D54	Microbiological tests carried out	No.
D55	Physical-chemical tests carried out	No.
D56	Radioactivity tests carried out	No.
D57	Water quality tests required	No.
D58	Aesthetic tests required	No.
D59	Microbiological tests required	No.
D60	Physical-chemical tests required	No.
D61	Radioactivity tests required	No.
D62	Compliance of aesthetic tests	No.
D63	Compliance of microbiological tests	No.
D64	Compliance of physical-chemical tests	No.
D65	Compliance of radioactivity tests	No.

In general, and given the centrality of technical data in the water establishments, estimates were made where possible and useful, and will be indicated as such. For the case of the water balance inputs, a water balance exercise is needed beyond simple calculations to establish reasonable estimates based on different approaches during the analysis.

D.1.3 CUSTOMER SERVICE DATA

Quality of service data covers service continuity, coverage, complaints, speed of service and the like. The quality of service is expected to be the main motivation and mission of the WEs and more generally the public sector as a whole.

The basis for data collection is the IWA water utility performance indicators and the needed variables. However, changes were made to accommodate the lack of data as well as the local specificities. We set out to collect variables from two categories: quality of service and demography.

Table D 1-11 IWA recommended variables related to quality of service

Code	Variable	Unit
F1	Population supplied	person
F2	Population supplied with service pipes	person
F3	Population served by public taps or standpipes	person
F4	Distance from water points to households	m
F5	Public taps and standpipes consumption	m^3
F6	Water points	No.
F7	Operational water-points	No.
F8	Public taps and standpipes	No.
F9	New connections establishment time	day
F10	New connections established	No.
F11	Customer meter installation time	day
F12	New customer meters installed	No.
F13	Connection repair time	day
F14	Connections repaired	No.
F15	Service complaints	No.
F16	Pressure complaints	No.
F17	Continuity complaints	No.
F18	Water quality complaints	No.
F19	Complaints on interruptions	No.
F20	Billing complaints and queries	No.
F21	Other complaints and queries	No.
F22	Written responses	No.

Table D 1-12 IWA recommended variables related to demography

Code	Variable	Unit
E1	Households and business supplied	No.
E2	Buildings supplied	No.
E3	Households and businesses	No.
E4	Buildings	No.
E5	Resident population	person
E6	Direct customer meters	No.
E7	Residential customer meters	No.
E8	Industrial customer meters	No.
E9	Bulk customer meters	No.
E10	Registered customers	customer
E11	Residential registered customers	customer

Also, some operational variables related to customers were recommended yet may not be applicable to the general situation in Lebanon as currently water metering is low.

Table D 1-13 IWA recommended variables related to operation of customer meters

Code	Variable	Unit
D39	Residential customer meter reading frequency	No. / meter
D40	Non-Residential customer meter reading frequency	No. / meter
D41	Bulk customer meter reading frequency	No. / meter
D42	Customer meter readings	No.
D43	Residential customer meter readings	No.
D44	Operational meters	No.
D45	Meter replacement	No.

However, to be better aligned with the objectives of this assessment and the local situation, the following table was selected to represent different aspects of service and the service area.

Table D 1-14 Revised variables related to service

Variable	Unit
Households and businesses (Units)	No.
Resident population	person
Units supplied legally by WE	No.
Units supplied by other entities	No.
Units supplied by illegal connections	No.
Population receiving continuous supply	No.
Time system is pressurized	No.
Average operating pressure	No.
Compliant response time	No.
New connections establishment time	No.
New connections establishment time	No.
Customer meter installation time	No.
Connection repair time	No.
Complaint response time	No.
Billing complaints and queries	No.
Service complaints	No.
Pressure complaints	No.
Continuity and interruption complaints	No.
Water quality complaints	No.
Metered customers	No.

The data collection will rely heavily on systems such as the billing system, client management system, which have been invested in heavily by donors and NGOs

D.1.4 ORGANISATIONAL UNIT RESPONSIBILITY FULFILMENT QUESTIONNAIRE

To assess and compare the outlined work responsibilities for the WE as per their organisational by-laws, a questionnaire was made in Arabic, tailored to the WE situation (See below a sample), that asks each unit if they implement the assigned tasks; and if not or not fully, then explain the perceived reasons.

الأسباب والنواقص	تحت التطبيق؟	المسؤوليات	No.
		مصلحة الموارد البشرية والمشتركين	
		دائرة الموارد البشرية	
		قسم شؤون المستخدمين والتدريب	
		درس حاجات المؤسسة من الموارد البشرية.	1
		اقتراح شروط الاستخدام وسلسلة الرتب والرواتب وملاك المؤسسة, وتعديلاتها بالتنسيق مع سائر وحدات المؤسسة.	2
		تنظيم المباريات والامتحانات واجرائها.	3
		تحضير ملفات الاستخدام والترفيع وكل المعاملات العائدة لها.	4
		تنظيم الملفات الشخصية وتبويبها.	5
		مسك الاحصاءات العائدة للعاملين في المؤسسة وتحضير معاملات النقل والمكافآت والتأديب وانتهاء الخدمة وسائر المعاملات المتعلقة بشؤونهم الذاتية.	6
		درس أوضاع المستخدمين وشؤونهم واحتياجاتهم من التدريب المتخصص بما فيها تلك المتعلقة بالحوافز التشجيعية.	7
		استلام الاجازات الإدارية والمرضية العائدة لكافة المراكز واجراء الاحصاءات المرضية وتسجيلها وحفظها ومتابعتها.	8
		تحضير جداول اسمية بدوام العاملين وايداعها المديرية العامة.	9
		وضع جداول بالحضور الفعلي للعاملين وايداعها قسم الرواتب والأجور.	10
		اصدار نشرات دورية تتضمن المعلومات الفنية والقواعد المتبعة في مراكز المؤسسة وتعميمها عليها.	11
		إدارة مراكز التدريب والاشراف عليها.	12
		تنظيم دورات على استعمال أجهزة الوقاية بالتنسيق مع مصلحتي المحطات والمشاريع والتوزيع والصيانة والاستثمار والسهر على صلاحية هذه الأجهزة وفعاليتها.	13
		اعداد المستخدمين الجدد على ممارسة مهام وظائفهم في ضوء أهداف المؤسسة وطبيعة أعمالها بما في ذلك التدريب على تقديم الاسعافات الأولية.	14
		تصميم برامج تدريبية متخصصة وإقامة دورات تدريبية دورية للعاملين في المؤسسة بالتنسيق مع كافة الوحدات.	15
		تأمين معاملات التدريب في الخارج مع مراجع المختصة.	16
		إدارة وتنظيم مكتبة مركزية لكافة المراجع تتضمن الكتب والمجلات والمطبوعات والمنشورات والأنظمة والبرامج المعلوماتية بالتنسيق مع كافة وحدات المؤسسة.	17
		متابعة مصادر المعلومات المتعلقة بمهام المؤسسة واقتراح ما هو ملائم ومفيد.	18

Figure D 1-1 An example of the organizational job responsibility questionnaire

Since the results of this questionnaire cannot be parametrized, it will serve as information gathering for later stages of the project and for truth-testing proposed improvements and interventions.

D.1.5 ACCOUNTING SYSTEM AND FINANCIAL DATA COLLECTION

D.1.5.1 Major sources of data for financial analysis: The Trial balance

Many financial, budget, accounting data have been collected from the WE, but it was decided to present the data collected from the *General Ledger* point of view, because these sources are the most detailed source of data for the WE.

All Opex and Revenues of the WE presented in this section were collected from the General Ledger, which represents the record-keeping system for the WE transaction data, with debit and credit account records validated by a trial balance.

A trial balance is a report that lists the balances of all General Ledger accounts of a company at a certain point in time. The accounts reflected on a trial balance are related to all major accounting items, including assets, liabilities, equity, revenues, expenses, gains, and losses. It is primarily used to identify the balance of debits and credits entries from the transactions recorded in the General Ledger at a certain point in time.

The trial balance serves to detect any mathematical errors that occurred in the double-entry accounting system.

The trial balance collected, when fully filled, provide a record of each transaction that took place during the life of the WE. It holds account information that is needed to prepare the financial statements. The WE was asked to provide the last 6 years of data, from 2015 to 2020, in order to make a significant analysis and evaluate the sustainability of the WE based on several historical data.

Transaction data are disaggregated, by type, into accounts for assets, liabilities, owners' equity, revenues, and expenses as listed in the table below

Table D 1-15 Data accounts as per GAAP

1 Assets
11000 Cash
13100 Accounts Receivable
14000 Inventory
14600 Goods Issued Not invoiced
17200 Buildings
17800 Accumulated Depreciation
19000 Deferred Tax assets
2 Liabilities
21000 Accounts Payable
22300 Deferred revenue
23000 Goods Received not purchased
26200 Deferred tax liabilities
3 Equity
31000 Common Stock
4 Revenue
41000 Goods
42000 Services
5 Expenses
51100 Cost of Goods Sold
52500 Other operating expenses
53000 Price difference

This It seems that this accounting system were developed some years ago with the USAID, but nobody has been able to confirm it.

The WE is expected to provide the following three major financial statements, as required under GAAP:

- The income statement
  It recaps the revenue earned by a company during the reporting period, along with any corresponding expenses; this includes revenue from operating and non-operating activities, allowing auditors, market analysts, investors, lenders, regulators, and any other stakeholders, to evaluate the company's financial cycle and results. It is sometimes referred to as the Profit and Loss (P&L) statement.

- The Balance Sheet
  It summarizes assets and sets them equal to liabilities and shareholder's equity. The balance sheet is an open snapshot of a company's assets and liabilities at a specific point in time.
  Balance sheets of the WE do not summarize assets correctly, so that even if it is balanced with liabilities, it gives a biased snapshot of the WE.

- The Cash Flow Statement
  It acts as a record of cash as it enters and leaves the company. The cash flow statement is crucial because the income statement and balance sheet are constructed using the accrual basis of accounting, which largely ignores real cash flow. Investors and lenders can see how effectively a company maintains liquidity, makes investments, and collects its receivables.
  The incoming and outgoing cash-flow of the WE seem to be correctly recorded, since WE accounting recording are sometimes audited. WE has to submit an annual budget, in which expenditures are authorized up to a maximum amount.

D.1.5.1.1 Administrative and budget organization of the WE

WE is subject to the following legal obligations.

- Administrative budget, showing:
- Expenses as approved by the budget, divided in two chapters
  - Normal expenditures (chapter 1 of the budget, literally translated and referring to Opex)
  - Investment expenditures (chapter 2 of the budget, literally translated and referring to Capex)
- Revenues
  - Operating revenues
  - Non-operating revenues
- The cash balance
- Accounting corrections
- A technical evaluation and a financial evaluation of the establishment's assets,

- A Trial Balance or General Ledger based on accounting system according to GAAP principles
- An annual technical and financial report submitted to the Ministry by April each year.

D.1.5.1.2 General note about Operational Expenditures

Opex are recorded in the Trial Balance under account №5, sorted by type.

However, a number of Opex are not recorded in the accounting system of the WE. This is the case of subsidies (never in cash) from donors and humanitarian associations in the form of supplies (i.e. repairing or replacement of equipment) or consumables (i.e. fuel for generators) to address emergency situations resulting from the current financial crisis and the inability of the WE to perform proper O&M.

As a result, the financial presentation performed hereinafter for the WE would be understated due to missing transaction entries.

D.1.5.1.3 Auditing of the WE

The accounts of the WE are subject to:

- Annual internal and external audits. The latter is carried out by third party auditing companies.
- Random Central Inspection controls, covering technical, administrative and financial aspects. This control has a regulatory dimension, as it ascertains the legality of procedures.
- Court of Audit control, essentially concerning the finances of the establishment.

D.1.6 LEGAL

Law № 221/2000 dated 26 May 2000, rectified by law № 241/2000 dated 7 August 2000 and amended by law № 377 dated 14 Dec 2001, restructured the water sector in Lebanon.

The law created four Regional Water Establishments (based in Beirut, Tripoli, Zahlehh and Saida) to consolidate numerous smaller water authorities, having moral personality and financial and administrative independence with the following prerogatives:

1. Each of the Water Establishment handles the following within its field of competence:
   - Studying, implementing, exploiting, maintaining and renewing water projects to distribute potable and irrigation water and collecting, treating and disposing of used water, according to the master plan for water and wastewater or upon previous approval by the Ministry to use public water resources or wastewater plant locations or discharge locations for wastewater.
   - Suggesting tariffs for potable and irrigation water and discharging wastewater, while taking into consideration the general socio-economic conditions.

- Monitoring the quality of distributed potable and irrigation water and the quality of wastewater on outfalls and waste water discharges.

2. Each WE has its own regulations. These establishments shall conclude contracts with an auditing company that is in charge of drafting a report on financial statements, closing accounts and internal control system adopted within the institution.

On the administrative level, Article 5 of Law 221/2000 and its amendments states that the public water exploitation establishments are governed by a Board of Directors, including a CEO and six members appointed by decree. The Board is entrusted with establishing all the internal regulations.

The adoption of the Law 221 in 2000 led to the promulgation of a number of by-laws in 2005 for BWE as follows:

- Decree 14598 of 14/6/2005 – Rules of procedure
- Decree 14599 of 14/6/2005 – Operating rules amended by Decree 1756 of 16/4/2009
- Decree 14636 of 16/6/2005 – Financial regulations
- Decree 14875 of 1/7/2005 – Staff rules and regulations
- Decree 14916 of 5/7/2005 – Administrative organization

The regulations that were promulgated are identical for the four public establishments, namely: the rules of procedure financial regulations and staff rules and regulations.

The operating rules are the same for the public water establishments of the Beqaa, Beirut and Mount Lebanon, and North Lebanon, the only exception being the operating rules of SLWE. Articles 56 to 86 in the operating rules were not incorporated into the operating rules of SLWE. These articles specifically concern the classification of land, irrigation water users, administrative provisions relating to subscription, contract and duration, delimitation of irrigation perimeters, the increase or reduction of such perimeters, equipment, and the required infrastructure. This is obviously explained by the need to avoid encroaching on the prerogatives of the Litani River Authority in charge of irrigation in certain regions of South Lebanon.

The administrative organization of the public water establishments as promulgated in the decrees differs from one decree to another and is, therefore, not identical.

D.2 COLLECTED DATA

The data collection in BWE was conducted mainly through a TA member who interacted with BWE staff. In the case of BWE, the data summaries were not provided as needed, yet a collection of detailed and sometimes raw data files were provided instead. This produced general uncertainty over the produced data since the detailed files, as rich in information as they were, did not always cover the entirety of the region or periods needed. At the same time, BWE provided good insights over data management issues.

Following are details of data collected in different areas.

D.2.1 HUMAN RESOURCES

D.2.1.1 Human Resources as per By-Law 14916

Bylaw 14916/5 July 2005 (*The Organization of the Beqaa Water Establishment and the details of its employees, grades, salary scale, and hiring conditions*) in an organizational set-up that can be summarized by the diagram shown on Figure D 2-1 below.

Of great interest is the number of staff assigned for each business function, regional department, and job type. This would allow the examination of how the envisioned organizational diagram can serve each and find areas that deviate from optimality. The required numbers of each job title are specified in the attached Table 1 of the by-law where the title and number of each position have been provided for BWE.

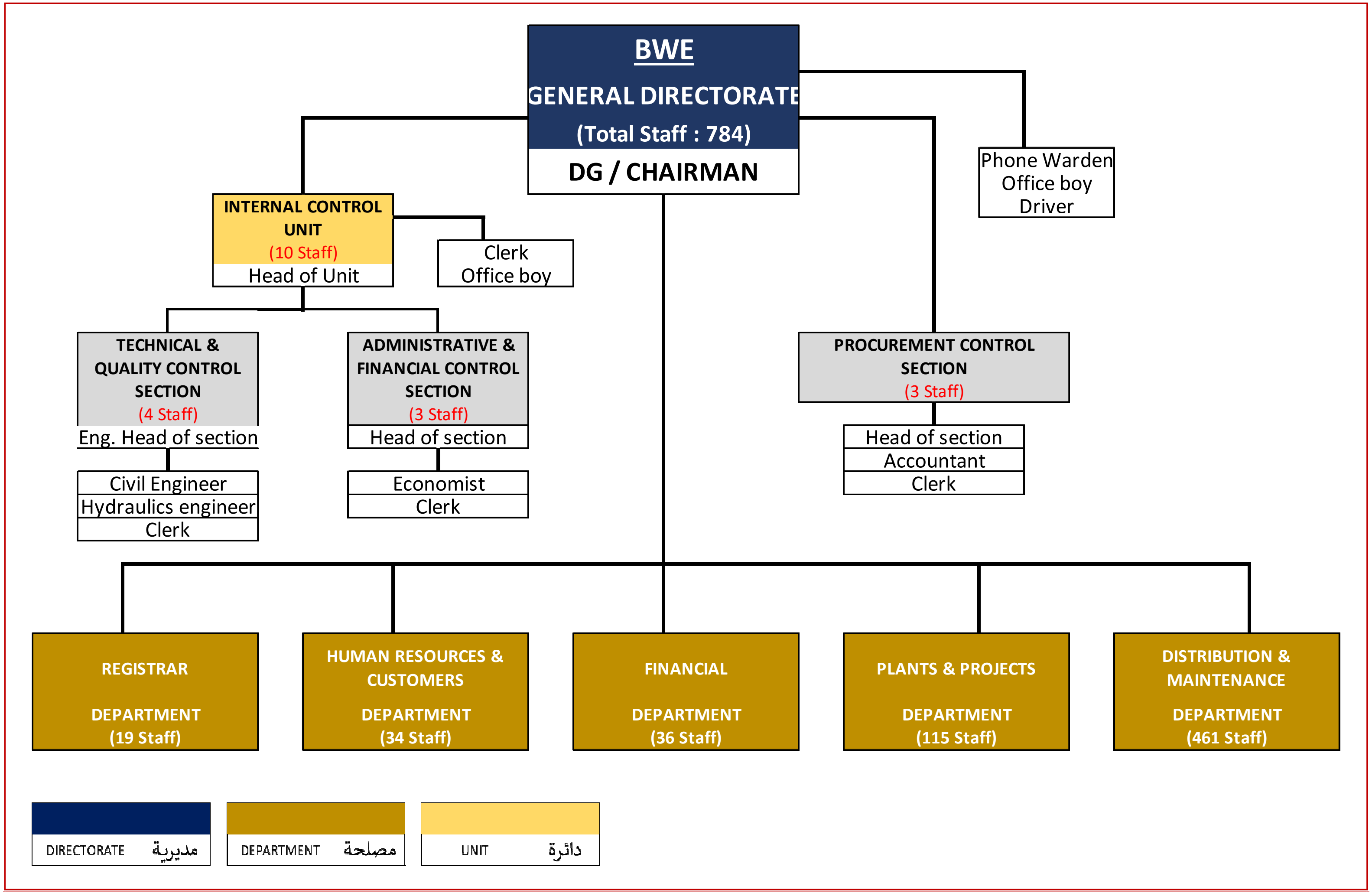

Figure D 2-1 BWE General directorate organigram

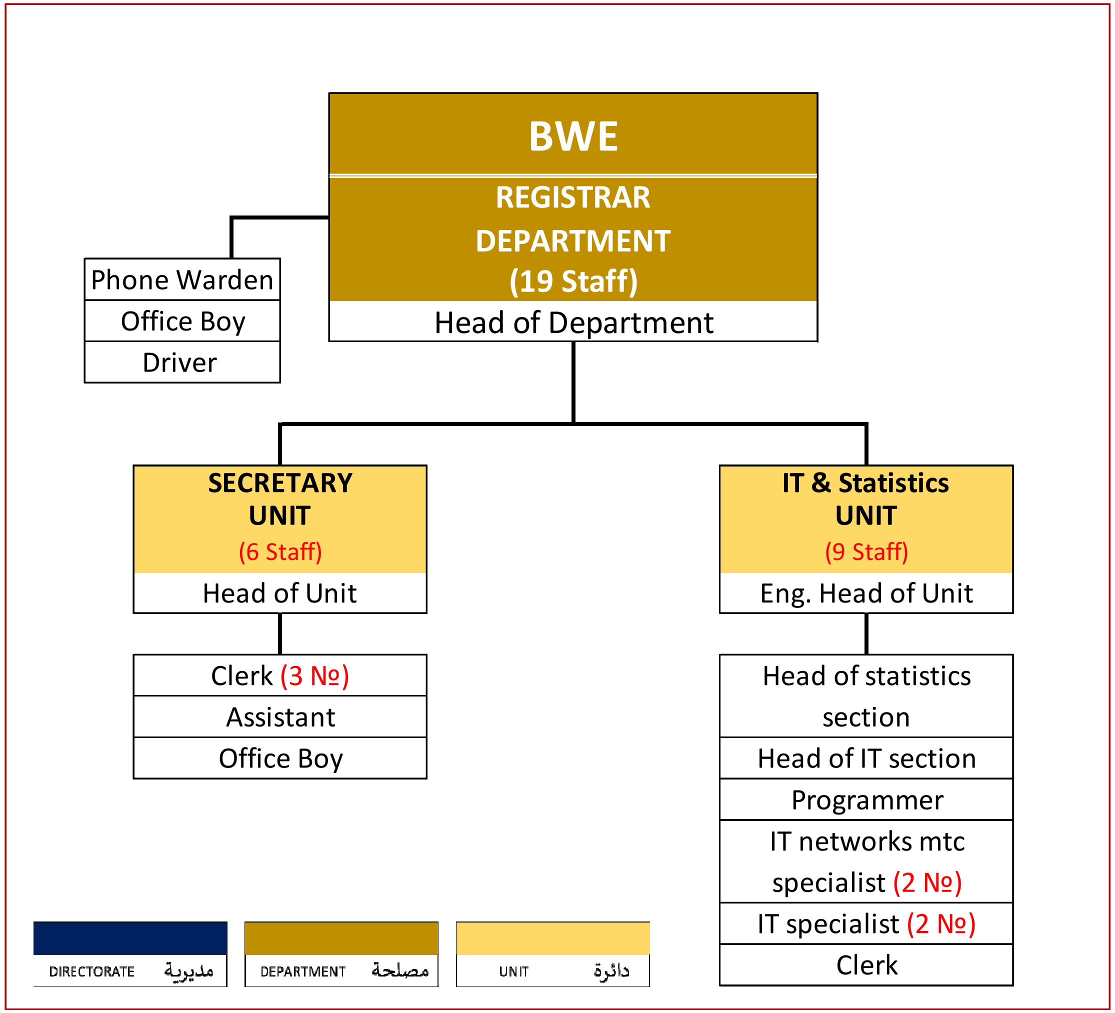

Figure D 2-2 Registrar department organigram

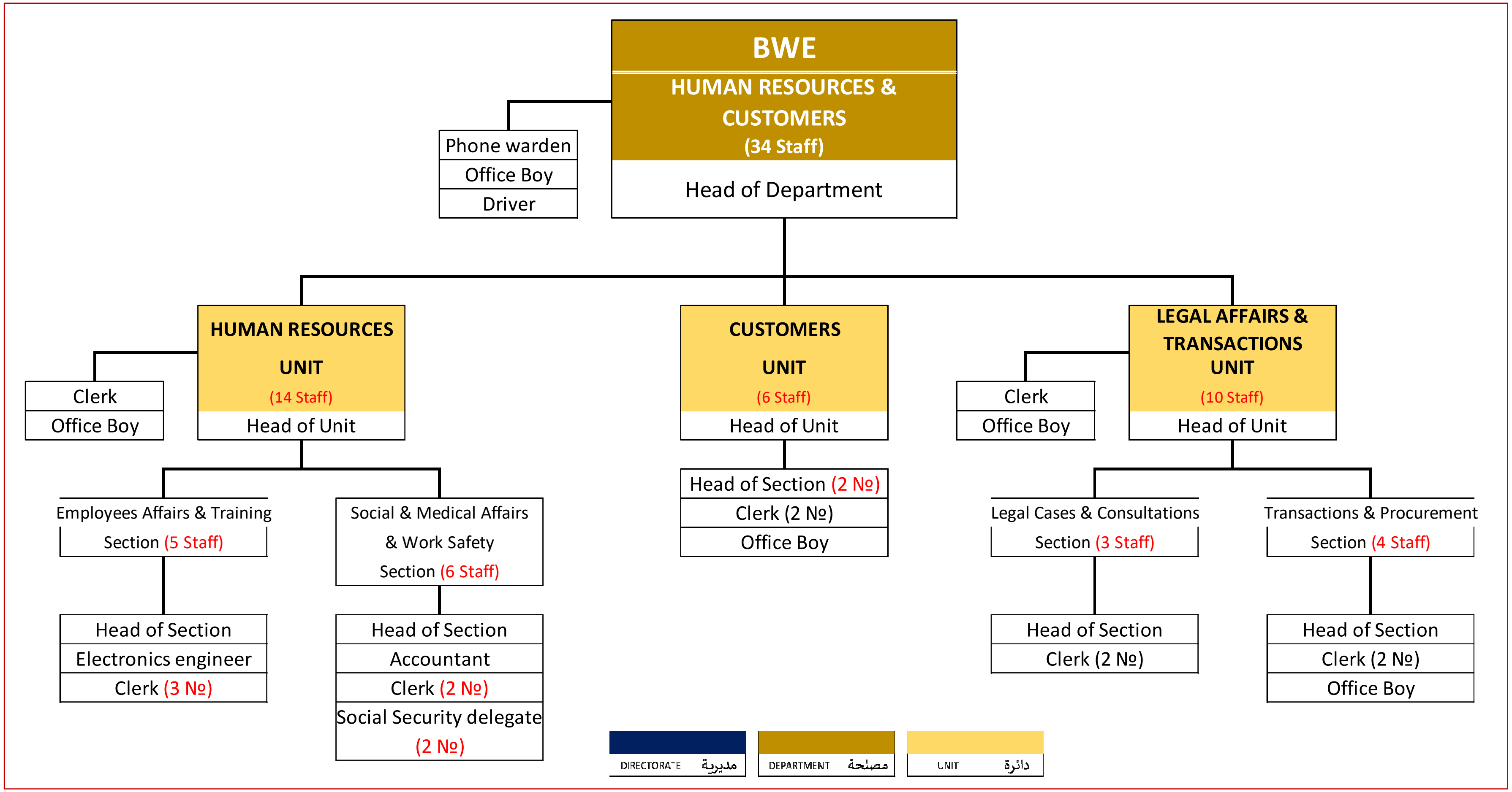

Figure D 2-3 Human resources and customers organigram

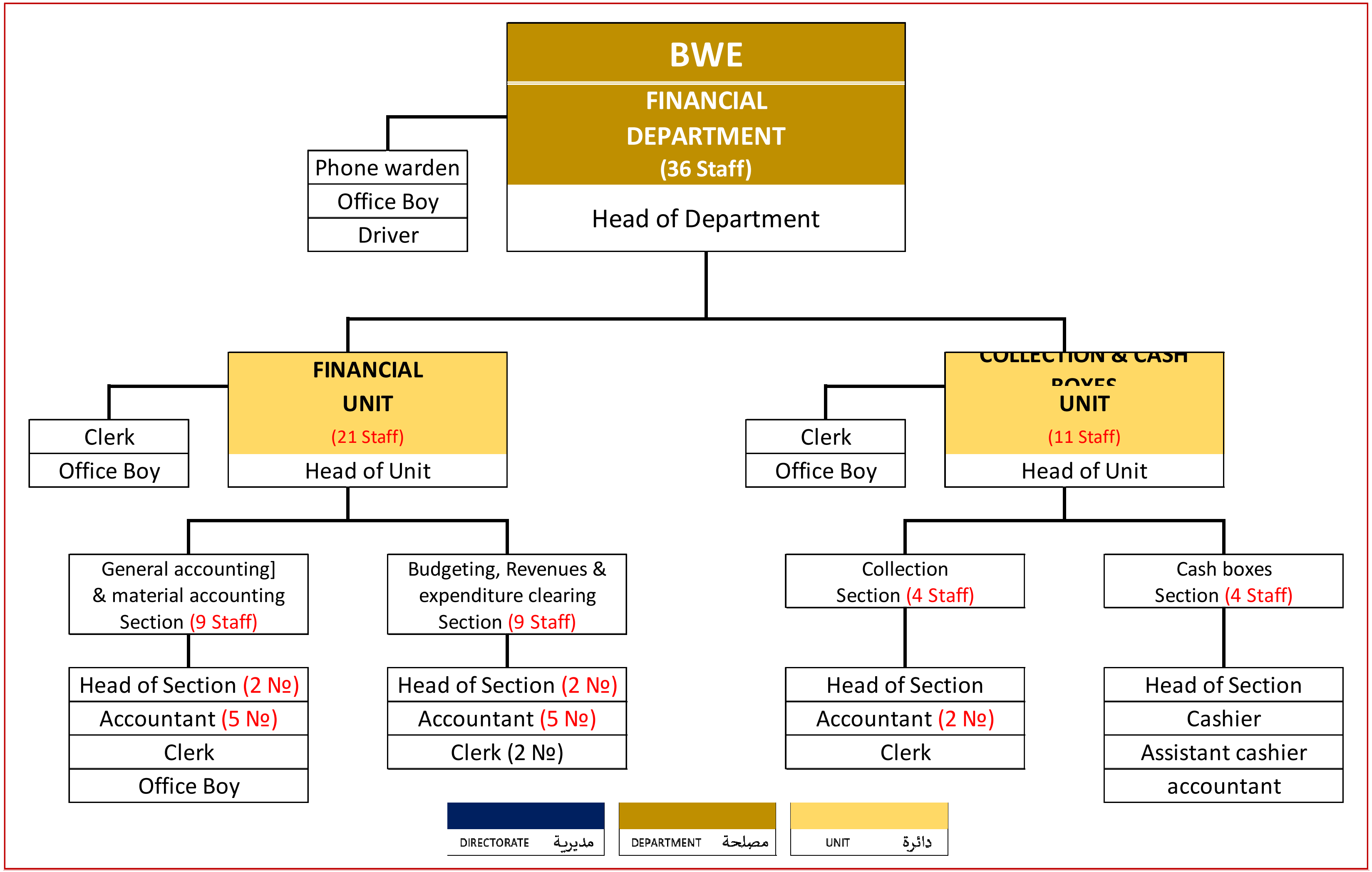

Figure D 2-4 Financial department organigram

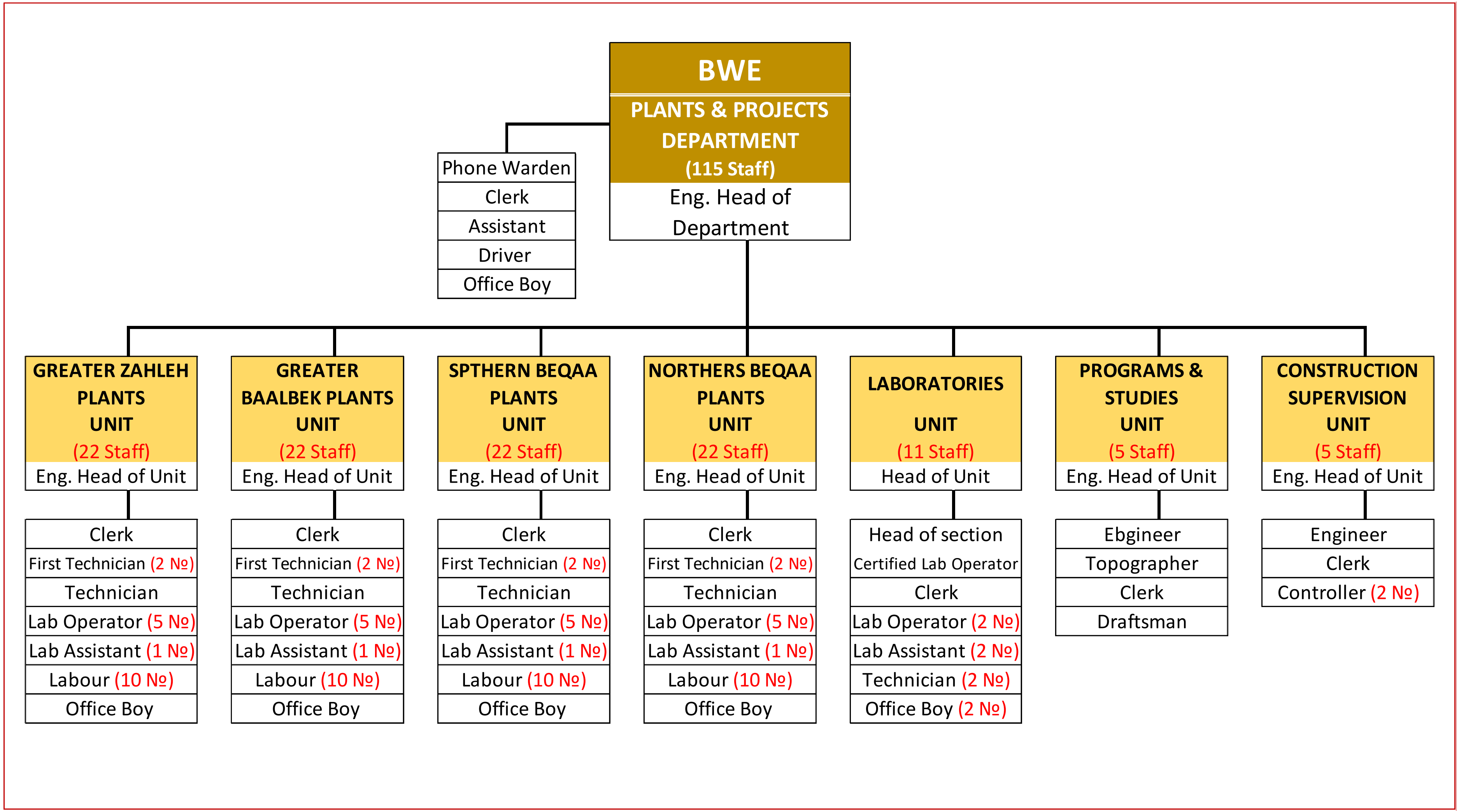

Figure D 2-5 Plants and projects organigram

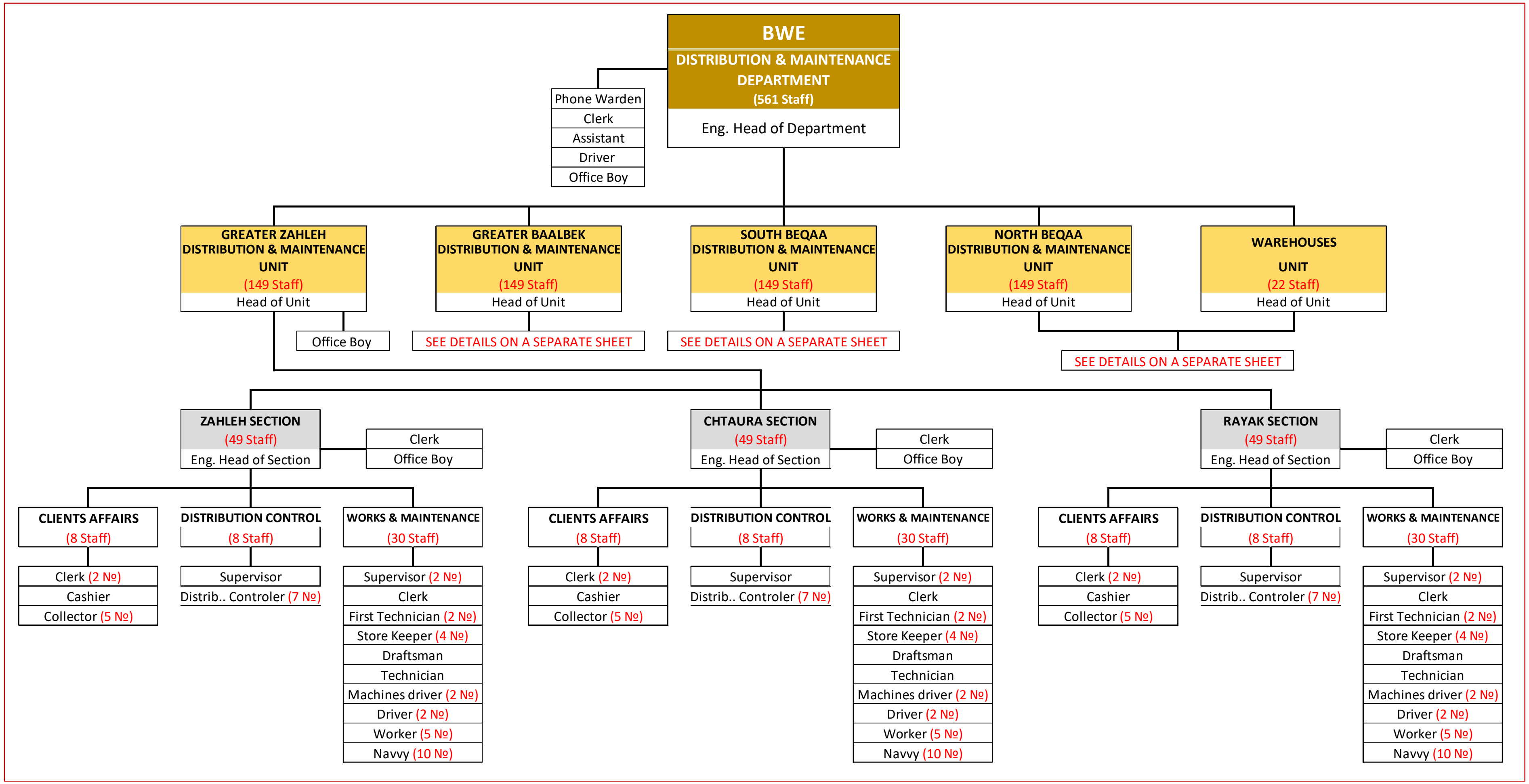

Figure D 2-6 Distribution and maintenance department organigram / Zahleh

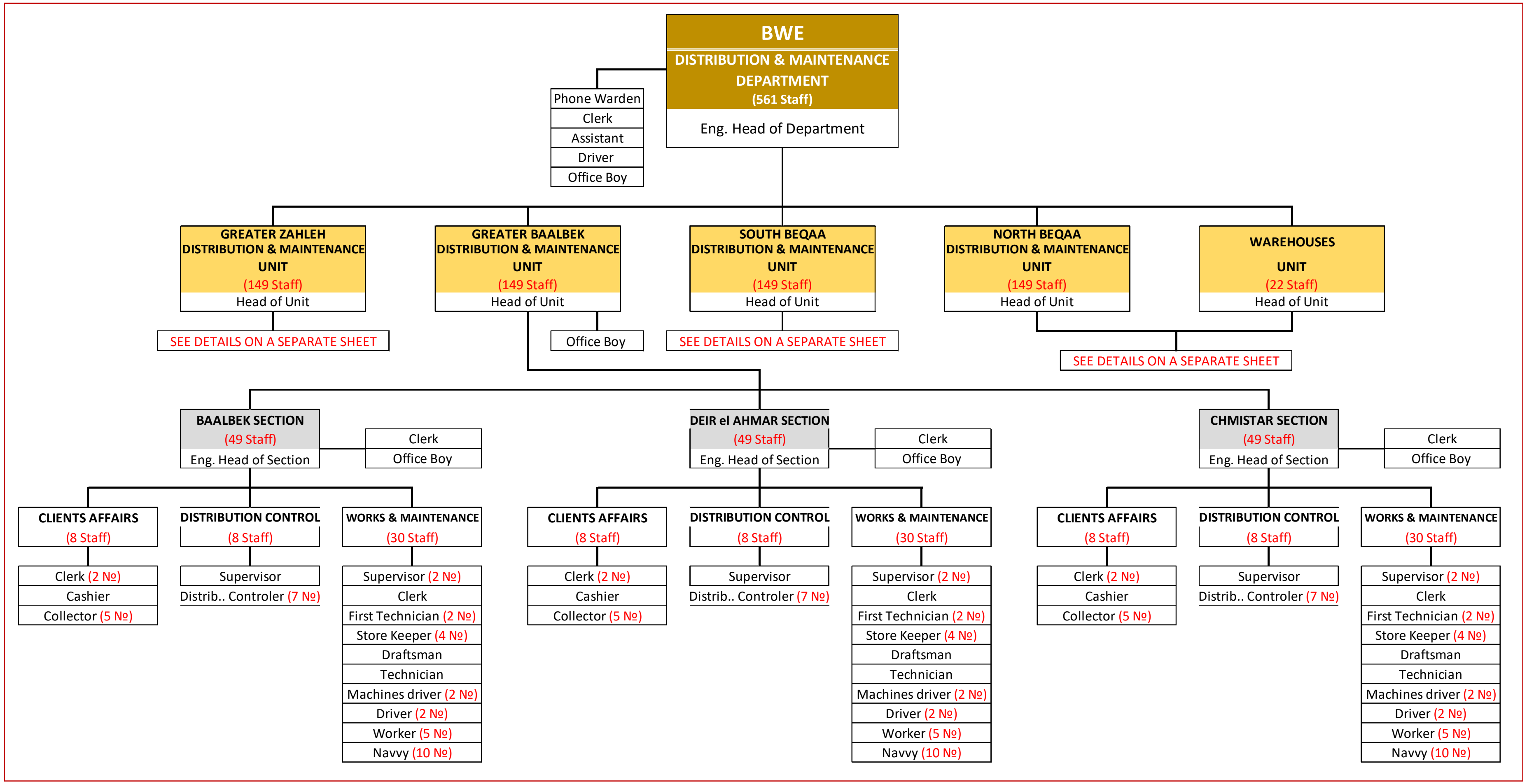

Figure D 2-7 Distribution and maintenance department organigram / Baalbeck

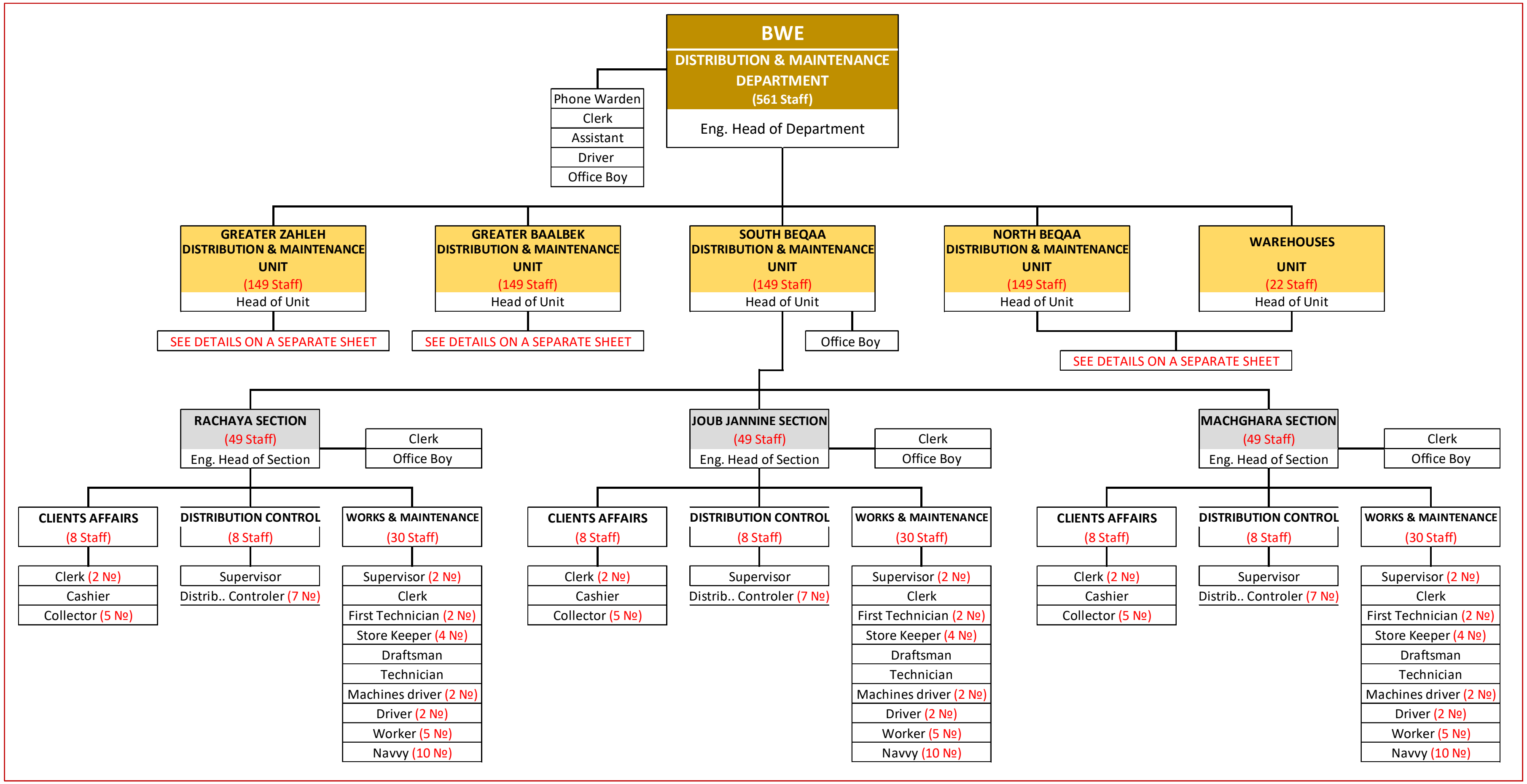

Figure D 2-8 Distribution and maintenance department organigram / South Beqaa

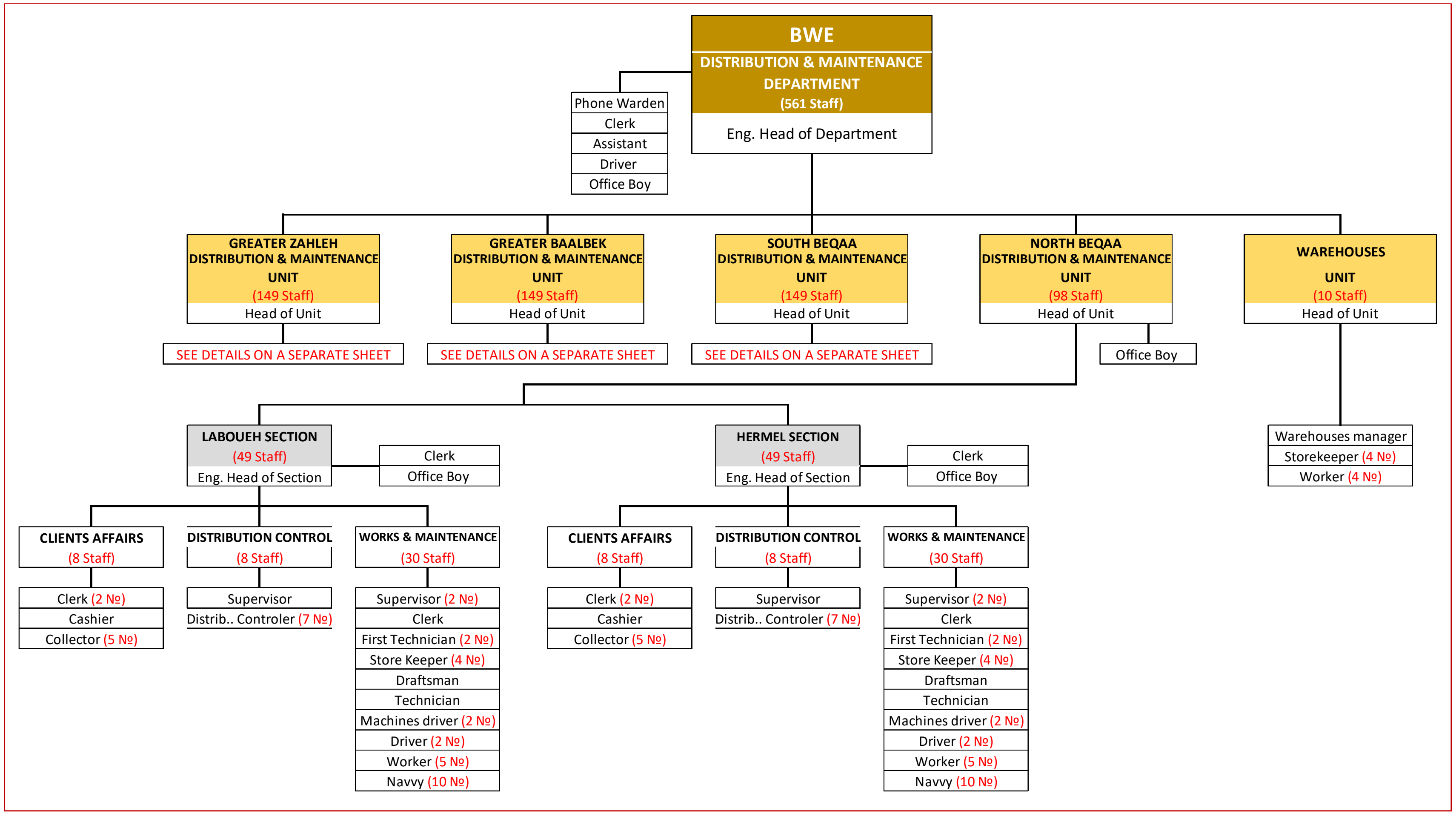

Figure D 2-9 Distribution and maintenance department organigram / *North Beqaa & Warehouses*

We proceeded to extract the information from this attachment into a detailed table of jobs to enable the collection of variables of interest.

Table D 2-1 BWE Distribution of staff by business area according to BWE organizational by-laws.

By-law Business area	Central	Baalbek	North Beqaa	South Beqaa	Zahleh	Grand Total
Customer service	6					6
Distribution	6	149	100	149	1h49	553
Engineering	10					10
Facilities		22	22	22	22	88
Finance	53					53
General	49					49
HR	14					14
Water quality	11					11
Grand Total	**149**	**171**	**122**	**171**	**171**	**784**

Table D 2-2 BWE Distribution of staff by job type according to BWE organizational by-laws.

By-law Business area	Central	Baalbek	North Beqaa	South Beqaa	Zahleh	Grand Total
Auxiliary - Clerical	41	7	5	7	7	67
Auxiliary - Driver	6	6	4	6	6	28
Auxiliary - Office boy	16	5	4	5	5	35
Collector/Reader		15	10	15	15	55
Customer Service		6	4	6	6	22
Financial / Administrative	26	15	10	15	15	81
Management	31					31
Management (Eng.)	5	5	4	5	5	24
Technical - Driver		6	4	6	6	22
Technical - Engineer	5					5
Technical - Laborer	4	55	40	55	55	209
Technical - Other	11	45	31	45	45	177
Technical - Water quality	4	6	6	6	6	28
Grand Total	**149**	**171**	**122**	**171**	**171**	**784**

The extracted information will enable the analysis of the allocation of staff with comparison to the system size and customers for each regional department as well as BWE as a whole.

D.2.1.2 Human Resources data as collected from BWE

D.2.1.2.1 BWE Annual Report 2016

The detailed 2016 report listed the total number of employees as 211 and the total number of on-demand personnel as 175 at the end of 2016.

It also listed several training courses, but the training hours were not listed. The report listed specifically 16 people issued 32 training permits in total, yet also listed 42 training sessions given.

Also listed the vacation days in detail that add up to 1872 administrative leave days, 656 medical leave days, 157 unpaid leave days, 7 marriage leave days, 5 paternity days, and 337 abstinence days. These all add up to 3034 leave days.

The report also gave overtime hours given and training given but the information could not be consolidated from the source in the current format.

D.2.1.2.2 BWE Annual Report 2018

The 2018 annual report charts the number of personnel in terms of employed staff and on-demand staff.

Table D 2-3 Personnel numbers listed in the 2018 annual report.

Personnel	2011	2012	2013	2014	2015	2016	2017	2018
Contracted	64	103	112	119	140	157	184	210
Employed	234	224	271	256	222	212	203	194

In addition, the report listed (6) seconded staff from various external agencies donors.

The report listed (5) staff members who attended training sessions in 2018, including (4) employees and one on-demand member, however, the training hours were not shown.

D.2.1.2.3 BWE Annual Report 2019

The 2019 annual report listed the number of personnel in terms of employed staff and on-demand staff:

Table D 2-4 Personnel numbers listed in the 2019 annual report.

Personnel	2011	2012	2013	2014	2015	2016	2017	2018	2019
Contracted	64	103	112	119	140	157	184	210	234
Employed	234	224	271	256	222	212	203	194	181
Total	298	327	383	375	362	369	387	404	415

Same as in 2018, the report listed (6) seconded staff from various external agencies donors.

D.2.1.2.4 MS NAV data export Raw data

The ERP system was set up as part of the LWP deliverables. The intended use of the HR module was to link employee data with salaries and costs in the financial modules and was never intended as a tool to analyze the composition of staff. The NAV ERP system contains the main database for managing personnel data in BWE, however external sheets are used to update contracted personnel information. Additionally, some details may be kept externally as needed but considerably less than in other WEs. Common issues found in this file include:

- Department and section information are not complete, therefore dividing personnel by regional department or section (cost center) cannot be accurately displayed.
- Empty fields in the database.
- Non-standard domains and no data validation.
- Domains do not allow quick representative display and charting of data.
- Data coverage (years).
- Inability to produce accurate retrograde reports.
- No drilldown by department/section and no unified position code.
- Confusion between on-hold, inactive, relocated, and terminated.
- Technical or Administrative designations do not update by position and no other means to categorize the employees.

Looking at positive aspects of the data, and due to validation used in the ERP HR module, the job is standardized whether when referencing the official designation or the current assignment.

This ERP table is a primary source of data given the reliance of BWE on that module. Therefore, and given that the number of employees is rapidly decreasing and given that attempting to sort the employees into specialty and education categories isn't based on highly reliable data, the accuracy ranges were selected in proportion to the number under each category. The data dates approximately to mid-2021.

Table D 2-5 Employees by job status.

Employee status	Central	Baalbek	North Beqaa	South Beqaa	Zahleh	Grand Total
Assigned job	25	22	2	11	17	77
Original job	8	28	9	21	21	87
Grand Total	**33**	**50**	**11**	**32**	**38**	**164**

Based on the actual job given, regardless of if original to the position or temporarily assigned, we used the data to extract the business area of each employed person.

Table D 2-6 Employees by business area.

Employee status	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
Customer service	3					3
Distribution	4	44	9	24	33	114
Facilities	2	5	2	8	5	22
Finance	7	1				8
General	14					14
HR	1					1
Water quality	2					2
Grand Total	**33**	**50**	**11**	**32**	**38**	**164**

In more detail, and based on the job title, we were able to sort the employees based on job type.

Table D 2-7 Employees by job type.

Employee status	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
Auxiliary - Clerk	1	4		1	1	7
Auxiliary - Driver	1					1
Auxiliary - Guard		5				5
Auxiliary - Office boy	1	1				2
Auxiliary - Phone operator	2					2
Collector/Reader		9	2	6	8	25
DG / General manager	1					1
Financial / Administrative	5	3		5	1	14
Management	18	8	1	4	6	37
Management (Eng.)	1					1
Technical - Laborer	1	12	4	12	6	35
Technical - Other	1	8	4	4	16	33
Technical - Water quality	1					1
Grand Total	**33**	**50**	**11**	**32**	**38**	**164**

The data provided also allows for classifying employee by educational level as follows.

Table D 2-8 Employees by education.

Employed Education level	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
University degree personnel	13	34	5	20	31	103
Basic education personnel	8	8	5	9	6	36
Other qualification personnel	12	8	1	3	1	25
Grand Total	**33**	**50**	**11**	**32**	**38**	**164**

Where basic education is differentiated by completing post-secondary school qualification such as trade school or an associate degree, and “other qualification” can include lower education as well as illiteracy.

D.2.1.2.5 BWE Header report table of contracted personnel

For managing contracted personnel. BWE uses a spreadsheet that contains the details of their on-demand staff contracts. The file is detailed and contains good historical and current information. The file, however, is not meant to be a human resource database given the nature of these contracts. IT was still possible to calculate estimates for the different variables needed. Such as how the contracted staff are divided across business areas and their job types.

Table D 2-9 Contracted personnel by business area.

Contracted business area	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
Distribution	2	32	23	33	38	128
Engineering	1					1
Facilities	19	4	4	9	16	52
Finance	3					3
General	16					16
HR	5					5
Water quality	5					5
Grand Total	**51**	**36**	**27**	**42**	**54**	**210**

Table D 2-10 Contracted personnel by job type.

Contracted business area	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
Auxiliary - Clerk	7	1			1	9
Auxiliary - Driver					2	2
Auxiliary - Guard		1	1	1		3
Auxiliary - Office boy			1			1
Financial / Administrative	7			2	4	13
Meter reader	1	4	1	2	2	10
Technical - Engineer	4	2	1	2	1	10
Technical - Laborer	6	22	20	21	23	92
Technical - Other	22	6	3	13	21	65
Technical - Water quality	4			1		5
Grand Total	**51**	**36**	**27**	**42**	**54**	**210**

The data also allows for classifying contracted personnel by education level to a certain degree as follows.

Table D 2-11 Contracted personnel by education.

Employed Education level	Central	Baalbeck	North Beqaa	South Beqaa	Zahleh	Grand Total
University degree personnel	13	34	5	20	31	103
Basic education personnel	8	8	5	9	6	36
Other qualification personnel	12	8	1	3	1	25
Grand Total	**33**	**50**	**11**	**32**	**38**	**164**

D.2.1.2.6 Summarized personnel numbers

Factors that may affect the accuracy of employee data include:

- The calculation adopted is based on the closing number of employees for each year. The more detailed recent data provided is for mid 2021.
- The number of employees will differ by a few people depending on their reported status. One employee is set “Inactive” while another is actively employed on the payroll but serving as an attaché at the MoEW. The accuracy band will remain at 0%-5%.
- The number of employees by regional department may differ significantly from reality, especially for previous years. The current situation is documented eithin a range of 5%-20% yet attempting to calculate over earlier years may produce lower distribution accuracy.

Based on the data sources provided, the following is the summary HR data. The exact number of staff whether employed or contracted is changing rapidly due to retirement and contract turnover. The following are indicatory to allow analysis to take place and highlight the main reform areas needed for improved management of BWE. In summary, BWE provided a good example for personnel data. The following table combines the above-mentioned figures for personnel numbers at the level of the establishment.

Table D 2-12 Combined personnel numbers.

Variable	By-laws	Employed	Contracted	Total staff
Business Area				
Customer Services	6	3	0	3
Distribution	553	114	128	242
Engineering	10	0	0	1
Facilities	88	22	52	74
Finance	53	8	3	11
General	49	14	16	30
HR	14	1	5	6
Water Quality	11	2	5	7
Job Type				
Auxiliary - Clerical	67	7	9	16
Auxiliary - Driver	28	1	2	3
Auxiliary - Guard	0	5	3	8
Auxiliary - Office boy	35	2	1	3
Collector/Reader	55	25	10	35
Customer Service	22	2	0	2
Financial / Administrative	81	14	13	27
Management	31	38	0	38
Management (Eng.)	24	1	0	1
Technical - Driver	22	0	0	0
Technical - Engineer	5	0	10	10
Technical - Laborer	209	35	92	127
Technical - Other	177	33	65	98
Technical - Water quality	28	1	5	6
Employed Education level				
University degree personnel		25	44	69
Basic education personnel		36	27	63
Other qualification personnel		103	139	242
Grand Total	784	164	210	374

D.2.2 TECHNICAL DATA

D.2.2.1 Water production and transmission system information

Water production and transmission management at BWE is mainly conducted by the Plants and Projects department. Basic system information such as the numbers of different primary network assets and the production quantities are both vital for several areas of analysis including:

- Non-revenue water
- Personnel sufficiency
- Asset valuation
- Automation needs assessment
- Energy efficiency

The following illustrates the sources of information that we were able to collect from BWE and the summary of data collected.

D.2.2.1.1 BWE Annual Report 2016

The 2016 report estimated that Beqaa area contains approximately 40 springs and 400 wells producing 68 million cubic meters per year. In more detailed tables, production sources are listed for each regional department. These figures do not specify whether these sources are in operation, owned by BWE, operated by BWE, or the entirety of wells in the service area.

Table D 2-13 Count of wells listed in the 2016 annual report.

Region	Wells
Zahleh	35
Baalbeck & North Beqaa	98
South Beqaa	80
Beqaa Territory Total	213

The detailed tables included in the report also included additional information such as pump horsepower, well depth, and meter and chlorination availability, but the information is largely incomplete.

The report then lists the estimated water by regional department as follows:

- Zahleh with 19 sources producing 52842 cubic meters per day.
- Baalbeck and North Beqaa with 34 sources producing 77070 cubic meters per day.
- South Beqaa with 34 sources producing 56485 cubic meters per day.

Totaling 87 sources and 186397 cubic meters per day. This estimate is therefore probably the basis for the figure given as 68 million cubic meters in annual production.

It is also assumed that the 200 to 400 wells in Beqaa may not be all responsible for the estimated production value but only those operated directly by BWE. Overall, information listed is inconsistent and unreliable.

D.2.2.1.2 BWE Annual Report 2019

The most recent annual report we had access to listed each source and the monthly estimates of production for that source. According to the data given, the number of stations for each regional department is as follows:

- Zahleh with 21 well, 2 springs, and producing 19426.9 cubic meters per day
- South Beqaa with 33 wells, and producing 8450 cubic meters per day
- Baalbek and North Beqaa with 48 wells, 2 springs, and producing 25792 cubic meters per day

Totaling 102 wells, 4 springs, and producing 53.7 million cubic meters per year.

Table D 2-14 Water production in 2019.

Region	Production 2019
Baalbeck and North Beqaa	25,792,987
South Beqaa	8,450,675
Zahleh	19,426,437
Total	53,670,099

Again, the exact number cannot be accurately determined as different tables list a different number of assets within the same report and no indication is given to whether these sources are owned by BWE, operated by BWE, or otherwise.

D.2.2.1.3 GIS summary file "Wells, PS, Springs, Reservoirs.xlsx"

A file that summarizes the data available in the BWE GIS included system assets from various sources, not all of them are under the control of BWE or active. The update date is unknown. Therefore, this source would list a larger number of system items summarized as follows:

Wells (298 total)

- Unclassified/private: 9
- Not in use: 1
- Assumed active in the Master Plan: 224
- Labelled as "new": 47
- Labelled as "Loaned": 17

Springs (68 total)

- Unclassified: 13
- Labelled as LibanConsult: 13
- Assumed active in the Master Plan: 42

Pump Stations (38 total)

- Unclassified: 2
- Labelled as Existing: 17
- Labelled as Proposed: 19

Reservoirs (320 total, 166252 cubic meters in volume)

- Unclassified: 4
- Labelled as New: 39
- Labelled as Existing: 248
- Labelled as Under Construction: 26

- Labelled as WTP: 3

Due to many of these assets are clearly either not owned by BWE, operated by BWE, or both, and given the question about the extent of the mandate of BWE to operate all public water supply systems in the service area, it was expected to find discrepancies with the reported sources which are supposedly responsible for the estimated production quantities, yet their data is vital for assessing BWE's capability at taking over the municipality owned and operated assets as well as differentiating irrigation from potable water assets.

D.2.2.1.4 BWE Asset Survey spreadsheets

To achieve better clarity and for calculating the financial value of assets, some raw data files were collected by BWE. The asset survey conducted under LWP relied on current data and sites data was largely incomplete and/or cannot be consolidated into useful data. Some site investigations were made but different data was updated in different locations with inconsistent criteria. Even a simple counting of the total number of each active asset type is therefore incomplete.

Table D 2-15 Number of assets from the "asset survey".

Department	Section	Reservoirs	Wells
Baalbeck	Baalbeck	22	34
	Chmestar	27	11
	Deir El Ahmar	23	8
Zahlehh	Zahlehh	10	10
	Chtourah	1	6
	Riyak	Unknown	Unknown
North Beqaa	Hermel + Labweh	26	5
South Beqaa	Joub Jannine	20	32
	Machghara	13	8
	Rashaya	36	36
Grand Total		**178**	**150**

The survey does not clarify the status of the asset since for most reservoirs the status was not clarified. The table below shows the status as concluded from a mixture of text comments and tags.

Table D 2-16 Status information the "asset survey".

Status	Reservoirs	Wells
Active	38	72
Not active	21	13
Needed Handover	3	4
(blank)	116	61
Grand total	**178**	**150**

Moreover, other data fields were not completed and therefore does not show to be a reliable source of data. All of this clearly shows the persisting need for a thorough asset survey in BWE.

D.2.2.1.5 Source Table "Annual 2019.xlsx"

Spreadsheets provided by the plants engineer detail the water production and energy consumption estimate for BWE as used in the 2019 annual report.

Table D 2-17 Summary of the production and energy for 2019.

Region	Production 2019	Energy kWh 2019
Baalbeck & North Beqaa	25,792,987	13,839,776
South Beqaa	8,450,675	11,568,505
Zahleh	19,426,437	20,839,351
Total	**53,670,099**	**46,247,632**

The file also contains a summary of stations by regional department as follows:

- Baalbek and North Beqaa 2 springs and 48 wells.
- South Beqaa 34 wells
- Zahleh 2 springs and 21 wells.

Showing again that the calculated production and energy results are for a subset of the total water assets in the Beqaa.

The files also show the flows and power for a number of stations in different regional departments, but does not show the head of each station, the hours of operation, or the number of pumps. The value from calculating standardized energy consumption would not be meaningful without accurate data.

The method for calculating the value was primarily based on instantaneous flow rates, estimated flows, real power readings, and other estimates. Fuel consumption was not available for comparison with power use in different locations.

Moreover, the file contained a list of SCADA stations with metering but the relationship between the readings of those stations and the used flow estimates aren't apparent.

This source does help to clarify the assets operated by BWE, and is the basis for the data used in the 2019 Annual Report.

D.2.2.1.6 Source Table "2020.xlsx" facility review

Spreadsheets provided by the facility engineers combined different sources of data and attempted at updating monthly production and energy amounts of sources. Many fields were incomplete. An example is when sorting by the operator and type, about half of entries weren't tagged for either or both criteria, as shown.

This incomplete effort was intended to resolve the different available sources of data. Unfortunately, most fields remained blank as can be seen from the table below. The data does however show that indeed the high estimate of wells and springs refer to assets that may not be operated or owned by BWE, with potentially different ways to resolve back to BWE given future events. Therefore, any assessment of staff size or operating costs should be tied to the future of those assets and the future shape of the BWE water supply system.

Table D 2-18 Summary of listed assets in the master list of facilities under review.

Operated by	Spring	Well	(blank)	Grand Total
BWE		61		61
Municipality		92		92
Other		56		56
Private		1		1
(blank)	61	81	25	167
Grand total	**61**	**291**	**25**	**377**

D.2.2.1.7 GIS export June 2021

Several tables were exported from GIS to help collect information on BWE's assets. The tables cover wells, springs, reservoirs, WWTPs, and the pipe network. Reliability suffers due to many fields not being completed.

BWE GIS data highly relies on the USAID Master Plan of 2015. The labelling of assets often indicates whether the data was given to BWE by the Master Plan or other sources.

Table D 2-19 Summary of GIS assets.

Region	Spring	Well	Reservoirs
Baalbeck	23	108	103
North Beqaa	11	42	45
South Beqaa	18	97	125
Zahleh	8	44	45
Grand total	**60**	**291**	**318**

Many of the wells have been identified as not being operated by BWE. However, the number is uncertain due to 80 wells not being tagged for operating entity.

Table D 2-20 Summary of GIS wells by status.

Operated by	Wells
(blank)	80
BWE	62
Municipality	92
Other	56
Private	1
Grand total	**291**

Moreover, free text notes indicate that 37 wells are not in use. However, the remaining wells were not confirmed to be in use. Comparing ownership and operation shows a mixture and many unknowns.

Table D 2-21 GIS well ownership vs. operations.

	Well operated by					
Well owned by	**BWE**	**Municipality**	**Other**	**Private**	**(blank)**	**Grand Total**
BWE	60	64	45		2	171
Municipality	2	26	11	1		40
(Blank)		2			78	80
Grand total	62	92	56	1	80	291

Similarly, the GIS survey did not specify the conditions of most wells.

Table D 2-22 GIS well condition vs. operations.

	Well operated by					
Well condition	**BWE**	**Municipality**	**Other**	**Private**	**(blank)**	**Grand Total**
Not in use	10	15	8		4	37
(Blank)	52	77	48	1	29	207
New					47	47
Grand total	62	92	56	1	80	291

D.2.2.2 Water Distribution system information

D.2.2.2.1 BWE Annual Report 2016

The report listed the following estimates 3000 km of network and 80,000 subscribers. Estimating an average of two subscribers per connection, that would amount to 40,000 legal connections.

D.2.2.2.2 GIS export June 2021

The length of pipe networks that was provided from the GIS export showed that in one file the segments were flagged as being digitized during or in relation the USAID Master Plan of 2015.

The total length of pipe does not reach more than half of the estimated 3000 km as mentioned in the 2016 annual report understandably as the master plan was not concerned with the details of local tertiary networks.

Table D 2-23 GIS transmission line status by length.

Status	Qty (m)
Assessment	765,718
Existing	506,395
Under construction	200,057
Grand total	**1,472,170**

In another table, and with little other information, more complete data was given about the water network. It is not known whether this is in addition to the lengths listed in the master plan GIS tables or different.

Table D 2-24 GIS network length.

Region	Length (m)
Baalbeck	1,484,317
North Beqaa	627,767
South Beqaa	991,504
Zahleh	988,890
Grand Total	**4,092,477**

The pipe material included some incorrect, invalidated inputs that seem to be the result of adding different naming standards from different sources and sometimes the incorrect field data. Overall, this stresses the importance of asset data update.

D.2.2.2.3 Operation and maintenance

D.2.2.2.4 BWE Annual Report 2016

The report listed details brief description works performed of various types by regional department. However, producing the data would require considerable effort.

D.2.2.2.5 BWE Annual Report 2018

The 2018 annual report listed efforts by the Distribution Department for disconnecting illegal connections and installation of flow regulators. However, no figures were given on the numbers of cases encountered.

The report also listed general network maintenance and extensions without giving a comprehensive report on achievements. However, some were listed and add up to 10,750 m of new networks in various projects.

From the Plants Department, the following breakdowns and repairs were listed:

- 7 cases in Zahlehh
- 56 cases in South Beqaa
- cases in Baalbek
- 1 case in North Beqaa

The report also listed some of the main factors limiting performance including:

- Document processing delays
- Parts shortage in warehouses
- Shortages in staff, equipped offices, and vehicles.
- Law enforcement support for removing illegal connections.

D.2.2.2.6 BWE Annual Report 2019

The 2019 annual report summarized the total number of transactions at the Distribution Department including registered work orders and repairs per regional department, without the ability to sort the results into different standard types, as follows:

Table D 2-25 Work orders and Repairs in 2019.

Variable	Baalbeck	North	South	Zahleh	Total
Work orders	1667	933	1281	2617	6498
Repairs	570	420	500	680	2170

Like 2018, the annual report lists a number of issues and challenges that include municipality and customer cooperation, lack of capacity for operations and maintenance, power outages, and lengthy procedures.

From the Plants Department, the following breakdowns and repairs were listed:

- 4 cases in Zahleh
- 23 cases in South Beqaa
- 11 cases in Baalbeck and North Beqaa

D.2.2.2.7 Source Table "Annual 2019.xlsx"

The spreadsheet contains the same listed repairs regarding stations and pumping as in the annual report of the same year:

- 4 cases in Zahleh
- 23 cases in South Beqaa
- 11 cases in Baalbek and North Beqaa

D.2.2.2.8 Source Table "All Vehicles"

The table shows the number of operational and total vehicles in different departments. The table can be summarized as follows:

Table D 2-26 Count of vehicles.

Region	Operational Vehicle	Not Operational	Total Vehicles
Central	12	2	14
Zahleh Distribution	11	2	13
North Beqaa Distribution	3	2	5
Baalbeck Distribution	7	1	8
South Beqaa Distribution	5	1	6
Plants and Projects	10	0	1

D.2.2.2.9 Source file "well maintenance 2020"

The file lists maintenance activities conducted by the Plants department in 2020. The listed activities are divided by regional department as follows:

- Zahleh plants: 7 repairs with approximately 5 possible pump repairs.
- South Beqaa: 24 repairs with approximately 14 possible pump repairs.
- Baalbeck and North Beqaa: 17 repairs with approximately 6 possible pump repairs.

D.2.2.3 Water Quality

D.2.2.3.1 BWE Annual Report 2018

The report listed the following number of water analyses performed in the water lab:

- 96 samples tested for physical-chemical properties.
- 1730 samples tested for microbiological properties.

The report gives a total of 1826 samples from 870 sampling locations. It is not clear however how many tests were conducted or the results of the compliance. The report also lists 76 samples taken and tested for physiochemical and microbiological properties in the wastewater lab. It is not clear however how many tests were conducted or the results of the compliance.

D.2.2.3.2 BWE Annual Report 2019

The report listed the following number of water analyses performed in the water lab:

- 100 samples tested for physical-chemical properties.
- 2012 samples tested for microbiological properties.

The report gives a total of 2112 samples from 1006 sampling locations. It is not clear however how many tests were conducted or the results of the compliance. The report also lists 100 samples taken and tested for physiochemical and microbiological properties in the wastewater lab. It is not clear however how many tests were conducted or the results of the compliance.

D.2.2.3.3 Raw water quality data export from GIS

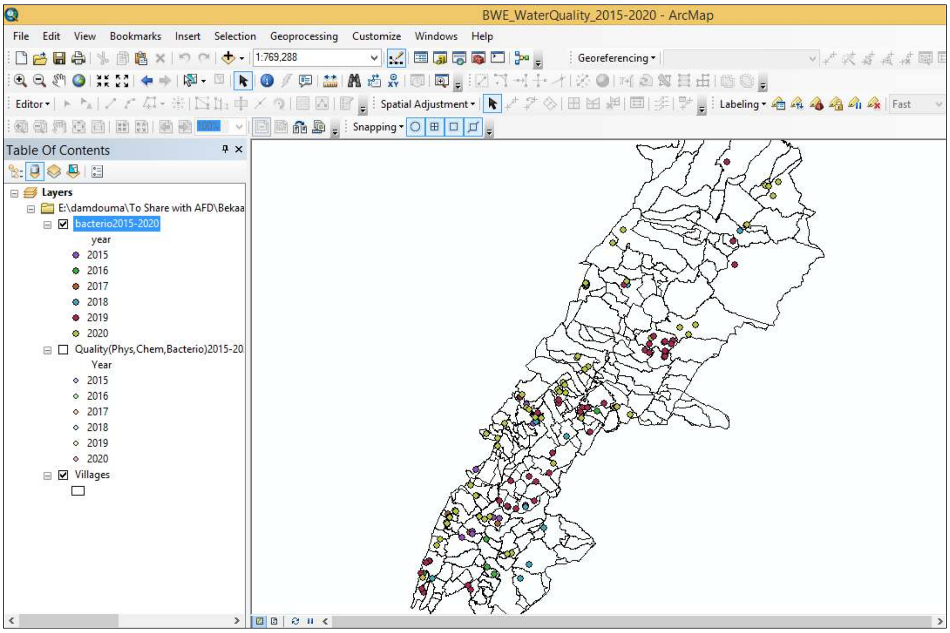

Figure D 2-10 Sample screenshot from GIS water quality mapping.

The available water quality sampling and testing data covering 2015 to 2020 was collected. The data contained a good record of samples and testing results. Some issues included:

- No reference number of needed tests per location.
- No reference for the regional branch or water system from which a sample was taken but only an invalidate descriptive text.
- No reference for when the sample is required, ad-hoc, or for private customers.
- No reference values for evaluating passing and failing of different tests.
- No locations specified for network tests.
- No method for easily reporting number of tests vs/ samples.

The data for microbiological tests is given separate from the physical-chemical and aesthetic tests. The microbiological test results listed were for E.coli and total coliforms. We used the Lebanese Standard 161:2016 to calculate the passing rate for the microbiological passing and failure.

Table D 2-27 Microbiological samples and calculated passing rate according to the Lebanese Standard 161:2016

Year	Samples	Total coliforms tests	E.coli tests	Total coliforms pass	E.coli pass	Total tests	Total pass	% pass
2015	835	835	835	574	647	1670	1221	73%
2016	1033	1033	1033	784	897	2066	1681	81%
2017	913	913	913	780	817	1826	1597	87%
2018	935	930	930	735	765	1860	1500	81%
2019	1006	1005	1005	907	939	2010	1846	92%
2020	1056	1054	1054	836	894	2108	1730	82%
Grand Total	**5778**	**5770**	**5770**	**4616**	**4959**	**11540**	**9575**	**83%**

For most samples, 28 different physical-chemical tests and a color aesthetic test were conducted. Since the raw data was not reported it was time consuming to calculate the exact number of tests conducted. As an estimate we will consider each sample to have been tested 28 physical-chemical tests and one aesthetic test with a margin of error. No radiological tests were reported.

Table D 2-28 Estimation of physical-chemical, aesthetic, and radiological tests

Year	Samples	Est. physical -chemical tests	Aesthetic tests	Est. radiological tests
2015	106	2968	106	0
2016	142	3976	142	0
2017	100	2800	100	0
2018	89	2492	89	0
2019	100	2800	100	0
2020	**65**	**1820**	**65**	**0**
Grand Total	**602**	**16856**	**602**	**0**

As for the completion of sampling records, and in general, the sample data was highly complete for locations linked to a facility asset, and otherwise for when the sample was taken from a network. The following tables tally the deviations found.

Table D 2-29 Microbiological sample data completion assessment

Year	Sequence No.	Sample ID	Sample Location	Sample Date	Source Name	Source Type	Linked Asset	Linked Asset ID	Result (P/F)
2015	100%	100%	50%	100%	100%	98%	51%	51%	0%
2016	100%	100%	57%	100%	100%	98%	58%	58%	0%
2017	100%	100%	58%	100%	100%	98%	59%	59%	0%
2018	100%	100%	52%	100%	100%	99%	53%	52%	0%
2019	100%	100%	53%	100%	100%	98%	54%	54%	0%
2020	100%	100%	49%	100%	100%	96%	51%	51%	0%
Total	**100%**	**100%**	**53%**	**100%**	**100%**	**98%**	**54%**	**54%**	**54%**

Table D 2-30 Physical-Chemical and Aesthetic tests data completion assessment

Year	No.	Sample ID	Sample Location	Sample Date	Source Name	Source Type	Linked Asset	Linked Asset ID	Result (P/F)
2015	100%	100%	95%	100%	99%	99%	99%	99%	0%
2016	100%	100%	95%	100%	100%	4%	100%	100%	0%
2017	100%	100%	98%	100%	100%	0%	100%	100%	0%
2018	100%	100%	99%	100%	100%	0%	100%	100%	0%
2019	100%	100%	97%	100%	100%	0%	100%	100%	0%
2020	100%	100%	94%	100%	100%	0%	100%	100%	0%
Total	**100%**	**100%**	**96%**	**100%**	**100%**	**18%**	**100%**	**100%**	**0%**

D.2.2.3.4 Water quality variable summary

Code	Variable	Unit	Region	2015	2016	2017	2018	2019	2020	Reliability	Accuracy (±)	Accuracy (± %)	Source
D52	**Water quality tests carried out**	No.	BWE	941	1,175	1,013	1,024	1,106	1,121	***	100	10%	GIS quality data
N/A	**Wastewater quality samples taken**	No.	BWE				76	100		**	20	20%	Annual reports
N/A	**Wastewater quality tests carried out**	No.											
D46	**Required treated water quality tests carried out**	No.											
D47	Required aesthetic tests carried out	No.											
D49	Required microbiological tests carried out	No.											
D50	Required radioactivity tests carried out	No.											
N/A	**Treated water quality samples taken**	No.	BWE	941	1,175	1,013	1,024	1,106	1,121	***	100	10%	GIS quality data
N/A	Microbiological samples	No.	BWE	835	1,033	913	935	1,006	1,056	***	10	1%	GIS quality data
N/A	Physical-chemical and aesthetic samples	No.	BWE	106	142	100	89	100	65	***	5	5%	GIS quality data
D51	**Treated water quality tests acrried out**	No.	BWE	24,321	30,099	26,577	27,204	29,274	30,718	***	1,500	5%	GIS quality data
D53	Aesthetic tests carried out	No.	BWE	106	142	100	89	100	65	***	5	5%	GIS quality data
D54	Microbiological tests carried out	No.	BWE	835	1,033	913	935	1,006	1,057	***	10	1%	GIS quality data
D55	Physical-chemical tests carried out	No.	BWE	23,380	28,924	25,564	26,180	28,168	29,596	***	1,500	5%	GIS quality data
D56	Radioactivity tests carried out	No.	BWE	-	-	-	-	-	-	***	10	> 50%	GIS quality data
D57	**Water quality tests required**	No.											
D58	Aesthetic tests required	No.											
D59	Microbiological tests required	No.											
D60	Physical-chemical tests required	No.											
D61	Radioactivity tests required	No.											
D51x	**Compliance of water quality tests**	No.											
D62	Compliance of aesthetic tests	No.											
D63	Compliance of microbiological tests	No.	BWE	574	784	779	735	907	836		50	5%	
D64	Compliance of physical-chemical tests	No.											
D65	Compliance of radioactivity tests	No.											

NB: *Quality tests are the tests carried out for different parameters required according to Lebanese standards in water quality testing.*

D.2.3 CUSTOMER SERVICE

D.2.3.1 Subscribers

D.2.3.1.1 BWE Annual Report 2016

The report listed the number of new subscribers by regional department in 2016 showed that not all requests were fulfilled. This data was not found for more recent years for comparison.

Table D 2-31 Subscriber transactions in 2016.

Region	Connection requests	Connections performed	Cancellations and on-hold requests
Zahleh	920	723	195
Baalbeck and North Beqaa	1,118	1,115	3
South Beqaa	307	247	60
Total	**2,345**	**2,085**	**258**

And a trend of the total number of subscribers from 2009 to 2016 as follows:

Table D 2-32 Number of subscribers.

Year	Subscribers
2009	66,095
2010	68,473
2011	72,240
2012	75,239
2013	77,334
2014	79,030
2015	81,726
2016	83,837

The source of the variations in customer numbers when distributed across geographical departments or by period as presented below for can be traced back to either backdated “new subscriptions” modifications or cancelations of subscriptions, or inaccuracies in the reports generated by the billing and collections module of the ERP system.

D.2.3.1.2 BWE Annual Report 2018

The 2018 annual report listed the number of registered subscribers over the years where the years 2015 to 2018 have been updated from the 2016 report as follows:

Table D 2-33 Number of subscribers.

Year	Subscribers
2009	66,095
2010	68,473
2011	72,240
2012	75,117
2013	77,189
2014	78,860
2015	81,179
2016	83,929
2017	84,920
2018	86,761

The report also listed the total subscribed quantity at 97164 cubic meters, 4717 of them being water rights. In more details, the report divides the customers and the quantity of water subscribed by region for the last two years as follows:

Table D 2-34 Quantity subscribed.

Variable	Period	Baalbek	North	South	Zahleh	Total
Customers	2017	21,051	9,328	21,724	32,655	84,758
	2018	21,383	9,492	22,323	33,257	86,455
Subscribed meters	2017	23,246	9,866	24,050	38,013	95,175
	2018	23,601	10,040	24,721	38,802	97,164

D.2.3.1.3 BWE Annual Report 2019

The report updated the number of customers for the year as follows:

Table D 2-35 Number of subscribers.

Year	Subscribers
2009	66,089
2010	68,473
2011	72,240
2012	75,117
2013	77,189
2014	78,860
2015	81,179
2016	83,929
2017	84,920
2018	86,761
2019	87,980

The report also provides a different sum for 2009 when either all registered customers or only active subscriptions are considered. Overall, the values are to be considered approximate.

Variable	Period	Baalbek	North	South	Zahlehh	Total
All registered customers	2019	22,052	10,032	23,780	37,431	93,295
Active subscriber	2019	21,301	9,848	22,413	33,091	86,653

A third group of figures are also provided for 2018 and 2019 for an assessment of the coverage by legal subscriptions and other entities in contrast to the estimated total number of buildings.

Table D 2-36 Summary of an exercise done by BWE to calculate legal service coverage.

Variable	Period	Baalbeck	North	South	Zahleh	Total
Customers	2018	21,448	9,456	22,455	33,402	86,761
Customers	2019	21,670	9,831	22,770	33,708	87,979
Units	2019	59,930	30,778	53,267	61,711	205,686
Supplied by others	2019	3,947	7,934	6,468	5,142	23,491
% Collection from subscribers	2019	34%	27%	37%	56%	43%

The report mentioned over 5000 customer meters having been installed without more details.

D.2.3.1.4 Updated subscriber report

An updated report shared by BWE showed the adjusted number of subscribers at the beginning of each year and the new subscribers registered during the year for giving the totals for the years 2015 to 2020 as follows:

Table D 2-37 BWE subscribers by region.

Region	2015	2016	2017	2018	2019	2020
Baalbeck	20,243	20,892	21,054	21,448	21,670	21,962
North Beqaa	8,766	9,230	9,291	9,456	9,831	10,140
South Beqaa	21,253	21,518	21,865	22,455	22,770	23,011
Zahleh	31,464	32,197	32,901	33,402	33,708	33,870
Total	**81,726**	**83,837**	**85,111**	**86,761**	**87,979**	**88,983**

D.2.3.1.5 Quantity report by BWE

BWE further supplied a more comprehensive table showing different quantities of water subscribed explained by different methods of estimation.

Table D 2-38 BWE billed quantity estimates.

		Water sales (nominal daily quantities)			
Year	**Number of subscribers**	**ERP report based on 2011**	**USAID est. based on sub. Type**	**Estimation based on 2018**	**BWE water sales**
2015	81,726	108,489	94,385	91,525	98,133
2016	83,837	111,291	97,784	93,889	100,988
2017	85,111	112,982	101,715	95,316	103,338
2018	86,761	115,173	108,958	97,164	107,098
2019	87,979	116,789	111,871	98,528	109,063
2020	88,983	118,122	117,344	99,652	111,706

D.2.3.1.6 Miyahcon project metered subscribers

Many subscriptions in BWE were covered by metering through the LWP and Miyahcon funded projects. In Miyahcon, approximately 1150 customer meters were installed. LWP figures are also available but those results were not made available yet.

D.2.3.2 Quality of Service

D.2.3.2.1 Complaint system output

The output from the complaint system was collected for the period from 2019 to 2021. The following issues were observed:

- Not all cases were classified by type.
- Date of closing the case is only indicated for one case.
- Team closing the case is not indicated.
- Service complaints and reports are not separated.
- Billing complaints not included.

Table D 2-39 2021 complaints by type.

Type of Complaint	No. of recorded complaints
Source failure	1
Pipe burst	1
Blocked Gauge	21
Leaking gauge	3
Low pressure	29
No water	227
Pollution	1
Muddy	1
Leakage	2
Flooding into home	1
(Blank)	15
Grand Total	302

It is also unlikely that the recorded complaints represent the actual concerns of the customers or even the actual number of complaints that BWE received which includes informal complaints and direct phone calls.

Table D 2-40 2021 complaints by method.

Method of reporting	No. of recorded complaints
In person	61
Phone	221
(blank)	20
Grand total	**302**

Moreover, the culture of formally reporting complaints is seen where the main office is, while regional complaints are usually handled regionally so may not show in the system.

Table D 2-41 2021 complaints by location.

No. of recorded comp	No. of recorded complaints
Laboue	5
Hermel	1
Baalbeck	15
Joub Jannine	4
Rashaya	1
Rayak	19
Zahleh	116
Chtaura	19
Mashghara	1
(blank)	121
Grand total	**302**

D.2.3.3 Service Coverage

D.2.3.3.1 BWE Annual Report 2016

The report listed a population summary broken down by regional department of both residents and registered Syrian refugees as follows:

Table D 2-42 Population estimates including Syrian refugees given in 2016.

Region	Lebanese	Registered Syrians	Total
Baalbeck	227,760	130,219	357,979
North Beqaa	36,003	6,395	42,398
South Beqaa	98,669	79,282	177,951
Zahleh	177,041	182,133	359,174
Grand Total	539,473	398,029	937,502

The report also stated that the WE was providing water supply for an estimated 525,066 people, with an estimate of 69% supply coverage.

D.2.3.3.2 BWE Annual Report 2019

The report listed the information summarized previously as follows:

Table D 2-43 Summary of an exercise done by BWE

Variable	Period	Baalbeck	North	South	Zahleh	Total
Customers	2018	21,448	9,456	22,455	33,402	86,761
Customers	2019	21,670	9,831	22,770	33,708	87,979
Units	2019	59,930	30,778	53,267	61,711	205,686
Supplied by others	2019	3,947	7,934	6,468	5,142	23,491

to calculate legal service coverage.

Of great importance, the report also listed the municipalities that perform autonomous water supply management.

D.2.4 ECONOMIC AND FINANCIAL DATA

D.2.4.1 Collected data

For the purpose of the financial performance diagnosis, key data encompassing technical, commercial and financial pieces of information was collected from BWE. BWE provided the requested data for the period between 2015 to 2017 from the following financial and accounting data sources:

- Trial Balance
- Administrative account
- Commercial account

- Tariffs
- The financial statements including Profit and Loss, Balance sheets, and Income statements

The objective is then to combine these data, produce some relevant ratios for displaying a clear picture of the situation of the WE.

In the following, a summary of economic and financial key figures is given for BWE's total service area.

D.2.4.2 Operational Expenditures

Expenses cover mainly cost of operation and maintenance that were extracted from the Trial Balance, account number 5, sorted by type. It is to be noted that a number of Opex are not recorded in the accounting system of BWE (See Sub-Section A. 0.5.3), which would bias the financial presentation performed hereinafter.

Expenses include variables costs such as energy and consumables while fixed costs cover the human resources, maintenance of the network, the equipment and the buildings, administrative and office expenditures, Water purchases, since BWE operates a number of private wells leased from the private sector, and financial expenses.

Variable expenses costs are those for Energy and consumables:

- Energy is provided from three different sources: EDL, EDZ, and power generators (sensitive to availability/price of fuel).
- Consumables are chemicals for water treatment.

Fixed expenses costs are all costs not falling under variable costs. These are mainly Human Resources, and other such as maintenance and administrative costs.

The following table shows the overall expenses costs broken-down by type for the period between year 2018 up to year 2020.

Table D 2-44 BWE Opex for 2018to 2020 (Source: BWE General Ledger)

DESC. / LBP	2018	2019	2020
HR	10,123,782,983	11,932,547,744	10,151,417,242
Admin	364,283,168	454,948,730	489,915,375
Energy	7,572,712,350	7,648,439,474	7,724,923,868
Fuel for Power generation	6,672,000	2,152,700	15,755,565
Operation & Maintenance	1,585,150,933	2,328,378,699	3,570,951,179
Studies	18,992,700	59,870,002	54,199,740
Grand Total	19,671,594,134	22,426,337,349	22,007,162,969
Third party financed O@M Zahleh /	2,700,000,000	2,700,000,000	2,700,000,000

It can be noted that a number of Opex were not assigned correctly and others were not included. The 2 main components of the costs structure are the Human resources and the

Energy, with respectively in average 50%, and 336% of the total Opex. The total of these components represent 86% of the total O&M costs. Maintenance costs is around 12% in average of the O&M costs. Revenues are generated from water pricing, and others services such as new subscription fees, fines and penalties, addition to Grants from various donors, as shown below.

Table D 2-45 BWE Revenues for 2018 to 2020 (Source: BWE General Ledger)

	2018	2019 (LBP)	2020
Grants for Network extension	18,342,510,000	18,830,142,560	18,706,848,577
Invoiced water subscription	24,290,499,933	24,964,880,799	25,431,943,516
Other revenues	713,274,006	674,380,865	705,305,612
Grand Total	**43,346,283,939**	**44,469,404,224**	**44,844,097,705**

Revenues from water pricing, which include Subscription and Maintenance, generate on average 55%, if grants are taken into consideration, of the total recurring revenues of BWE. Other revenues come from fees for new subscriptions, fines and penalties.

D.2.4.3 Tariffs and subscriptions

Hereinafter in this sub-section are given the tariffs and bills for the various types of subscriptions, in accordance with articles 30, 31, and 89 of Decree № 14599 dated 06/14/2005 and its amendments as per Decree 1756/2009.

D.2.4.3.1 Domestic users

Applies to residential apartments, offices, small shops, and the like.

1. Potable water right (Owned Gauge)

   This type of subscription is a holdover from past practice when consumers bought the right for 1 m³/day (or more) as private, bequeathable property.

   It is not practiced anymore. However, old rights (approximately 4 000) are still in force and special tariff applies to those cases.

Table D 2-46 BWE tariff for Owned Gauge subscription

	(LBP) Not connected to WW	Connected to WW
Water subscription	95 000	95 000
Maintenance	20 000	20 000
Computerization	5 000	5 000
Waste Water Subscription	15 000	60 000
VAT (11%)	14 850	19 800
Stamp	1 000	1 000
Rounding	150	200
Yearly tariff	**151 000**	**201 000**

2. Gauge subscription

Table D 2-47 shows the yearly lump sum against a nominal 1 m³/day* consumption.

Table D 2-47 BWE tariff for Gauge subscription

	(LBP) Not connected to WW	Connected to WW
Water subscription*	180 000	180 000
Maintenance	20 000	20 000
Computerization	5 000	5 000
Waste Water Subscription*	15 000	60 000
VAT (11%)	24 200	29 150
Stamp	1 000	1 000
Rounding	800	850
Yearly tariff	**246 000**	**296 000**

* Applies for apartments up to 200 m²
For apartments between 200 and 300 m², min subscription is 2 m³/day and the tariffs double.
For apartments exceeding 300 m², min subscription is 3 m³/day and the tariffs triple.

3. Water meter subscription

Over and above the fees for the gauged subscriptions, subscribers are charged an additional 1 000 LBP for each m³ exceeding the subscribed for annual volume, which is:

- For housing units below 200 m^2: 365 m³/year (1 m³/day)
- For housing units between 200 and 300 m^2: 730 m³/year (2 m³/day)
- For housing units exceeding 300 m^2: 1095 m³/year (3 m³/day)

However, none of the above is currently applied as the water meters are not read. Subscribers pay the same lump sum as for gauged subscriptions.

D.2.4.3.2 Irrigation subscriptions

Yearly subscription fee is 21 000 LBP. In addition, tariff related to volumes used is calculated as per the following formula, to which are applied computerization fees, stamps, and rounding as required:

$$T = t \times h \times d \times O$$

Where:

- ***T*** is the water tariff to be paid
- ***t*** is the cost of one hour of water supply, depending on the irrigation season, as follows:
  - Between 1 April and 5 May 12 000 LBP/h
  - Between 6 May and 6 July 14 000 LBP/h
  - Between 7 July and 4 Nov. 18 000 LBP/h
- ***h*** is the number of irrigation hours
- ***d*** is the number of irrigation days during for a given season.
- ***O*** is the number of "*outlets*".
  an *outlet* is an opening providing around 60 m³/hour (roughly a 5-inch diameter pipe)

Currently at BWE, irrigation service is provided on a daily basis against cash receipts for booked irrigation hours.

D.2.4.3.3 Touristic subscriptions (Restaurants, cafes and cinemas):

The tariff subscription for this type of customers is calculated considering the rate of 1 m³ per day subscription and two cubic meters per day for each restaurant or café of area below fifty square meters, and this volume shall be raised at the rate of one cubic meter for each increase of fifty square meters or its fraction - five meters for each cinema.

Table D 2-48 BWE tariff for Touristic subscription

(LBP)	Not connected to WW	Connected to WW
Water subscription	N* x 180 000	N* x 180 000
Variable up to 50 m2	1000 LBP per m3	1000 LBP per m3
Maintenance	20 000	20 000
Computerization	5 000	5 000
Waste Water Subscription	15 000	60 000
VAT (11%)	24 200	29 150
Stamp	1 000	1 000
Rounding	800	850
Yearly tariff	**246 000**	**296 000**

* N = 2 for restaurant sand coffees
N = 5 for cinemas

D.2.4.3.4 Hotels and hospitals:

One cubic meter for every four beds with the condition that the subscription is not less than five meters per day. The number of beds is determined according to a permit from the Ministry of Tourism, and with regard to hospitals according to a permit from the Ministry of Public Health.

D.2.4.3.5 Copy centers, Schools, laundries:

The tariff subscription for these types of customers is calculated considering the rate of 1 m³ per day subscription and the following:

- Two meters per day for each copy center
- Three meters per day for the small (regular) laundry
- One meter per day by the meter as a minimum for each external school assuming that the number of students does not exceed fifty, and this volume of water is raised at the rate of one meter for every fifty students, or its fraction.
- Ten meters a day as a minimum for each boarding school, provided that the number of students does not exceed three hundred students, and this volume of water shall be raised at a rate of three meters for every fifty students, or its fraction is more than three hundred students.

D.2.4.3.6 Mills, olive pressing mills and baking factories:

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and three cubic meters per day as a minimum, provided that the water establishment determines the actual need based on a report prepared by the technical unit.

D.2.4.3.7 Mosques and churches

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and three cubic meters per day as a minimum, provided that the water establishment determines the actual need based on a report prepared by the technical unit.

D.2.4.3.8 Gas and washing stations

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and a minimum of two cubic meters per day for each station without the washing garage, and a minimum of ten cubic meters for each station with a washing garage.

D.2.4.3.9 Resorts with swimming pools

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and ten cubic meters per day as a minimum (summer and winter).

D.2.4.3.10 Studios

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription. One cubic meter per day as a minimum for each studio for film endorsement, and two meters per day as a minimum for each theatrical or cinematic studio.

D.2.4.3.11 Factories

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and three cubic meters per day for the factory as a minimum, and this volume is increased according to the establishment's estimation of the actual needs, and one cubic meter per day for each sweets shop without a factory as a minimum.

D.2.4.3.12 Poultry and animal farms

The tariff subscription for this type of customers is calculated considering the tariff for 1 m3 per day subscription and three cubic meters per day as a minimum for each farm, and this quantity is raised according to the establishment's estimation of the actual need based on a report prepared by the technical unit.

D.2.4.3.13 Construction works

The tariff subscription for this type of customers is calculated considering the tariff rate for 1 m3 Two cubic meters per day for the construction of area less than two hundred square meters, and this volume shall be raised at the rate of an additional cubic meter whenever the area increases by one hundred square meters and up to a thousand square meters, provided that the mandatory water volume in all cases does not exceed ten cubic meters, whatever the area.

D.2.4.3.14 Firefighting

In the event of a fire, the institution puts at the disposal of the concerned firefighting services the running water in its pipes through the water outlet and the firefighting outlets designated for that. Therefore, the subscribers are not required to demand any compensation from the Water establishment for water interruption and disruption as a result of fire extinguishing works.

D.2.4.3.15 Others

The minimum quantities of water required for the facilities not mentioned above shall be determined by an agreement between BWE and the concerned person/authority in light of the assessment of the actual needs required for them.

D.2.4.4 Billing

D.2.4.4.1 Rate of billing

Billings for the water, sanitation and irrigation services are issued on a yearly cycle (once a year). Customer may pay the dues in up to four instalments provided the board of directors has taken the decision and approved it by the ministry of water and energy for that year Payments not received by the due dates are charged a late payment charge (2% of invoice amount per month as per decree № 14599), up to full invoice value. Late payment fees have been subject to 85% reduction on decision by the board, and the approval by the ministry.

D.2.4.4.2 Billing method

Current charges are itemized for each service and other items as prescribed by the administration:

- Water Subscription charge is uniform among all customer of regular types (Gauged and metered subscription) =180,000 LBP/m^3 (140,000 LBP/m^3 until 2013)
- Water Subscription charge for owned subscription is 95,000 LBP/m3 for both connected and not to waste water systems
- 1,000 LBP per m3 for the excess of consumption for metered subscription (Yearly Nominal consumption are respectively 365 m3, 730 m3 and 1095 m3 for housing units of area below 200 m2, area between 200 m2 and area above 300 m2 (Currently this item is not charged since no readings are done).
- Maintenance charge is 20,000 LBP for unmetered subscribers and 35,000 LBP for metered subscribers.
- Sanitation charge= 60,000 LBP/m^3 for customers connected to a wastewater treatment plant, and 15,000 LBP/m3 for customers not connected to a WWTP.
- Other items include the computerization charge (5000 LBP), stamp (1000 LBP) upon payment against each receipt, fines, and rounding,

It is worth noting that the ERP database indicates that the subscribers are classified by connection type (metered or unmetered) but all customers are charged based on flat tariff irrespective of the amount of water consumed. Tariff structure has barely changed since the inception of the water establishment and this is largely the result of a unique policy situation.

Table D 2-49 Billing data base and updated number of subscribers

Year	Number of Subscribers	Water Sales (daily cubic meters)
2015	81,726	NA
2016	83,837	NA
2017	85,111	NA
2018	86,761	97,164
2019	87,979	NA
2020	88,983	101,570.00

D.2.4.5 Collection

D.2.4.5.1 Collection method

All charges for utility services are due upon an announcement made by BWE, and published in the official gazette, and are payable as per the following options:

- To Collectors: The collectors are responsible for the collected money and they must dispatch it to the cashier periodically without exceeding the cash limit set by the rules with respect to their deposited guarantee. The collectors can make more than 2 visits to their assigned subscribers to collect the bills which adversely affect the collection efficiency especially reaching out to customers with debt and in distant villages.
- To Cashiers (office collectors) in branch offices in the following regions: Baalbeck, Zahleh, North Beqaa and South Beqaa.
- Online payment option, to improve the efficiency of collection, with debit/credit cards has not been implanted in BWE. However, agreements with OMT and Cash United offer customers the possibility of settling their dues through their offices across Lebanon. Those multiple payment options will allow the customers to save time and effort and find more locations with the widespread network of OMT and Cash United.

Table D 2-50 BWE Collection rate by section

Section	2015	2016	2017	2018	2019	2020
Hermel	24.29%	30.84%	25.83%	27.86%	33.73%	22.31%
Laboue	18.03%	20.18%	27.25%	19.50%	14.53%	12.73%
Baalbeck	36.34%	35.51%	34.80%	32.78%	32.14%	30.09%
Chmistar	22.51%	16.52%	16.36%	12.12%	13.33%	14.04%
Deir Al Ahmar	50.43%	44.46%	49.20%	40.95%	30.17%	34.19%
Rayak	37.59%	36.49%	39.04%	39.17%	36.49%	30.39%
Zahleh	50.15%	51.59%	48.15%	47.24%	47.51%	43.47%
Chtaura	32.72%	31.05%	39.91%	34.41%	35.62%	33.37%
Joub Jannine	21.16%	19.22%	22.25%	18.81%	21.57%	14.82%
Mashghara	54.53%	60.24%	60.87%	55.88%	55.96%	55.14%
Rachaya	11.03%	18.81%	18.59%	15.91%	15.55%	11.43%

D.2.4.6 Capital expenditure

Capex are recorded in the administrative accounting system. But, there is another recorded amount for Capex in the trial balance for Grants for new networks.

Table D 2-51 BWE Capex

	2018	2019 (LBP)	2020
Water	230,852,488	229,347,616	272,859,411
Administrative	39,959,940	38,200,636	48,637,920
Wastewater			
Irrigation	-	-	-
Transport	-	-	-
Other		-	-
Grand Total	270,812,428	267,548,252	321,497,331
Grants for new Works	18,342,510,000	18,830,142,560	18,706,848,577

84 % of the investment recorded in the administrative accounting system are for water assets.

D.2.4.7 Assets valuation and depreciation

Depreciation of the physical assets consists of the mean depreciation rate of all classes of assets, applied to is the net aggregate recorded asset value at the end of each year..

Table D 2-52 Asset Depreciation for years 2015 - 2020

	2015	2016	2017	2018	2019	2020
Fixed assets Total	**172,317,280,645**	**182,671,240,835**	**187,861,943,369**	**192,038,223,124**	**196,085,038,207**	**200,006,402,023**
Depreciation	5,341,835,700	5,662,808,466	5,823,720,244	5,953,184,917	6,078,636,184	6,200,198,463
Net Assets	166,975,444,945	177,008,432,369	182,038,223,124	186,085,038,207	190,006,402,023	193,806,203,560

However, BWE does not have a complete and accurate valuation of the assets, and therefore it is accepted that the above figures only present an approximate of the actual asset depreciation.

D.2.4.8 Financial statements

BWE issue each year an income statement, a cash flow statement and Balance Sheet. The table hereunder present the income statement for year 2015, 2016 and 2017.

Table D 2-53 Income statement of BWE, in Million LBP

Cash Flow statement	**2018**	**2019**	**2020**
Revenues and Collection			
Revenues collected current year	8,925,783,000	8,599,928,000	7,874,284,000
Other revenues (subscription, services…)	770,566,000	733,073,000	764,377,000
Revenues collected arrears	2,796,405,000	2,226,946,000	2,855,045,000
Other revenues MoEW subsidy	2,094,880,000	0	0
Total Revenue	14,587,634,000	11,559,947,000	11,493,706,000
Taken from reserve money	0	0	0
to feed budget items	0	0	0
to recover previous budget	0	0	0
Total Taken from reserve money	0	0	0
Total revenues under collection, including those taken from the reserve money	14,587,634,000	11,559,947,000	11,493,706,000
Expenditures			
Operational expenditures – Chapter 1	13,596,479,000	16,315,228,000	14,539,930,000
Investment expenditures – Chapter 2	270,812,000	267,548,000	321,497,000
Total expenditures	13,867,291,000	16,582,776,000	15,304,311,934
Balance	720,343,000	-5,022,829,000	-3,810,605,934
End of year			
Accounts receivable	161,110,259,000	175,107,567,000	189,104,875,000
Accounts Payable	92,743,595,000	98,817,302,000	104,813,615,000

Table D 2-54 BWE; Sample Cash situation statement in LBP (2017)

	Outflows	Inflows
	(M LBP)	
RECEIPTS		
Rental water subscription allowances		176,064,000
Sewage allowance		19,266,250
Current year collections		6,442,806,632
Current year sewage collections		713,709,500
Collections from previous years		2,335,005,928
Collections of previous years of sewage		138,329,300
Various imports		259,153,274
Water fines		101,123,035
Extraordinary imports		
Extraordinary imports		
VAT		1,016,312,481
Stamp		52,971,000
Enter		
Warranty (satisfactory assistance from warranty)		53,454,362
Spend (3%)		
Rebates		
Decimal notations		
Reservations		
Guarantees		70,000,000
Pay an advance		51,600,000
Recovery		1,071,005
Balance at 31/12/2016		13,999,086,762
PAYMENTS		
Appropriations of the Board of directors and the Commissioner of the Government	40,188,000	
User salaries	3,227,717,480	
Contractors salaries	83,000	
Procedure fees	15,745,035	
Compensation for dismissal from service	703,595,498	
family compensation	216,129,000	
Compensation for additional work	351,985,673	
Temporary monthly transfer compensation	443,800,000	
Compensation for water allowance	19,378,333	
Illness and death aid	30,639,600	
Education, marriage and childbirth grants	563,503,609	
Production grant	302,030,339	
Administrative expenses	292,977,413	
Expenses for levying	33,885,185	
Move and move	98,255,090	
Payments internal and external relations	16,630,662	
Consulting services and studies	59,497,886	
Taxes, fees, fines and court fees	1,178,000	
Electrical power	1,504,453,628	
Fuel for pumping stations	5,011,500	
Fuel for transportation and machinery	51,299,600	
Sterilization materials and laboratory supplies	4,029,500	
Buyer of water and investment rights	48,846,000	
Drinking water maintenance	231,263,029	
Irrigation water maintenance	3,321,000	
Sewage maintenance	3,406,000	
Administrative and office maintenance	49,776,548	
Maintenance of means of transport, machinery and equipment	16,657,747	
Manpower on demand	2,229,480,783	
Responses	2,703,400	
Judicial rulings and reconciliations	1,813,358,179	
Contributions to the National Social security fund	206,658,848	
Drinking water installations and installations	741,006,190	
Administrative and office equipment and construction	30,033,034	
Wastewater installations and installations	1,994,000	
out of Budget	533,633,187	
Balance at 31/12/2017	11,535,801,553	
Total	**25,429,953,529**	**25,429,953,529**

D.2.5 KPI

Basic KPIs are consistently monitored such as population, subscriber count, collection rates and efficiency per locality and aggregated to sections, branches, and establishment, revenue growth, profit margin in addition to other financial KPIs when requested by the MoEW.

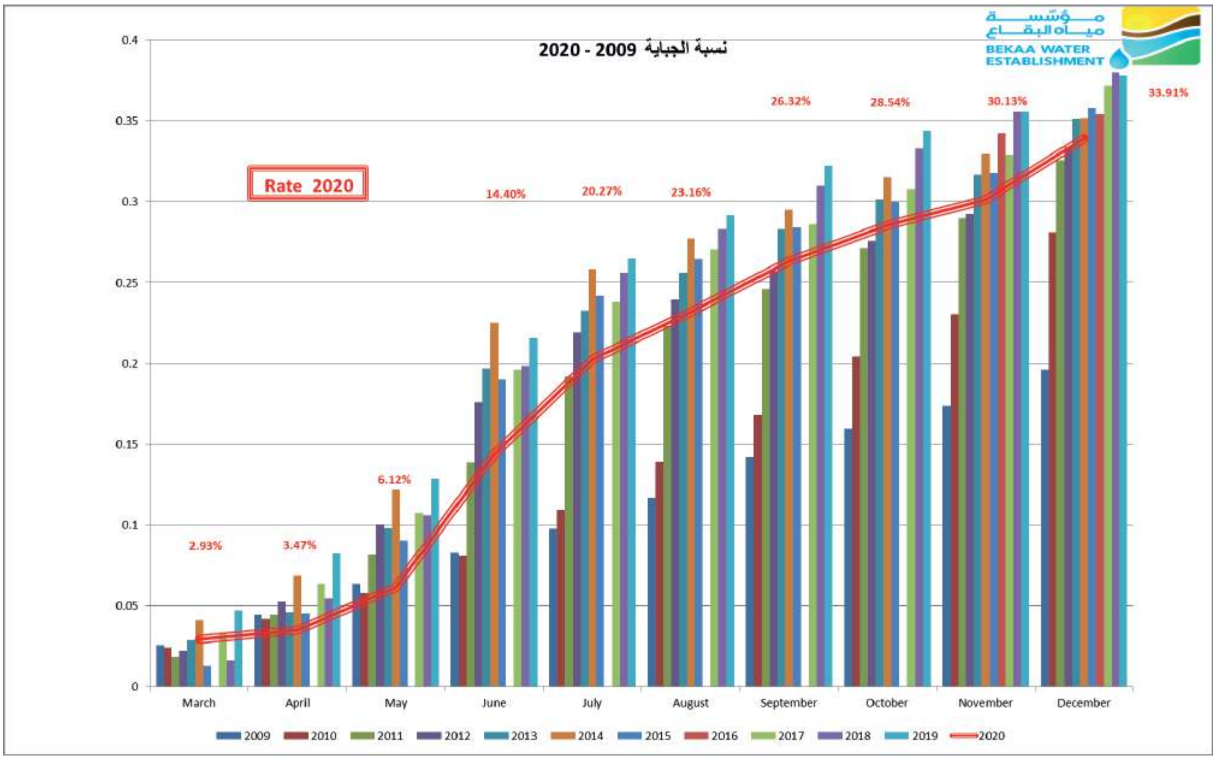

Figure D 2-11 Monthly collection rates 2009-2020 / BWE annual report

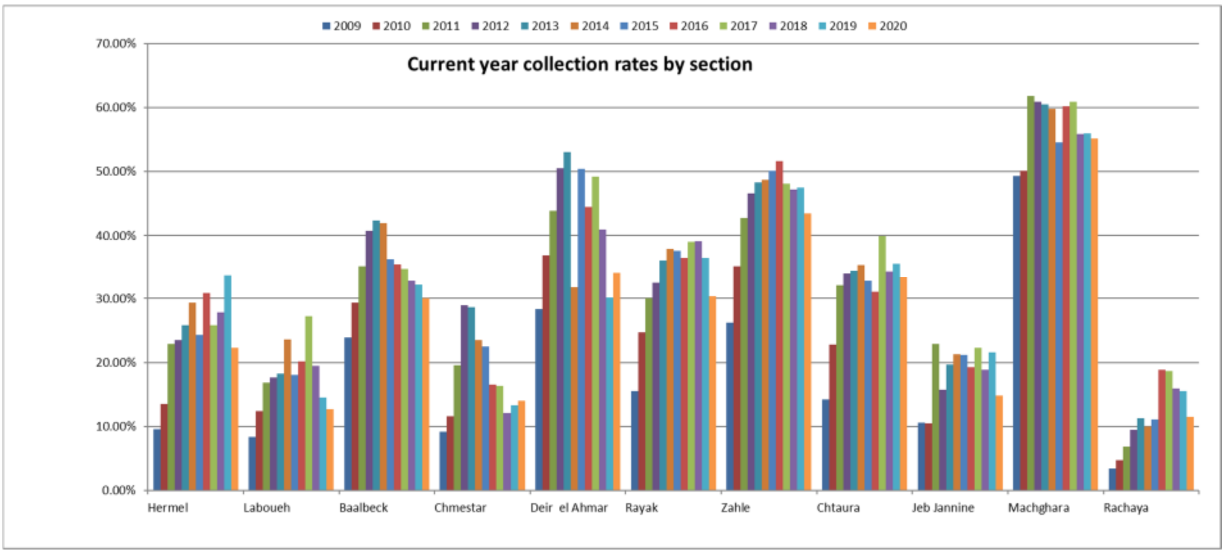

Figure D 2-12 Monthly collection rates by section 2009-2020 / BWE annual report